



**CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING
Engineering and Construction Division**

**PROJECT MANUAL
Miscellaneous Large Diameter
Water Line Improvement – Package 1
WBS No. S-000900-0163-4**

VOLUME 1 of 1

Divisions 00 through 16

October 2016

Engineer: Abdollah Setarehaseman
P.E. Serial No.: 68184
Firm: Nathelyne A. Kennedy & Associates, Inc.
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Document 00010

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NOTE: Bold capitalized Specification Sections are included in the City of Houston Department of Public Works and Engineering Standard Construction Specifications for Wastewater Collection Systems, Water Lines, Storm Drainage, Street Paving, and Traffic located here: <https://edocs.publicworks.houstontx.gov/all-documents/engineering-and-construction/specifications.html>; and are incorporated in Project Manuals by reference as if copied verbatim. Documents listed "for filing" are to be provided by Bidder and are not included in this Project Manual unless indicated for example only. The Document numbers and titles hold places for actual documents to be submitted by Contractor during Bid, post-bid, or construction phase of the Project. Specification Sections marked with an asterisk (*) are amended by a supplemental specification, printed on blue paper and placed in front of the Specification it amends. Documents in the 200, 300 and 400 series of Division 00, except for Document 00410B – Bid Form, Part B, are not part of the Contract.

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LIST OF PREQUALIFIED ASBESTOS & LEAD ABATEMENT CONTRACTORS

1.0 DOCUMENT INCLUDES

- A. Authorization.
- B. List of Authorized Contractors.

2.0 RELATED DOCUMENTS

- A. Section 13280 – Hazardous Materials Remediation
- B. Section 13281 – Abatement of Asbestos/Lead Containing Materials

3.0 AUTHORIZATION

- A. The List of Prequalified Asbestos & Lead Abatement Contractors (“List”) was authorized on January 7, 2004 by City of Houston Council Motion No. 2004-0030.
- B. Only those firms on the List can be utilized by Bidder in subcontracting for asbestos or lead abatement included in the Work.
- C. The List is administered by Building Services Department. All inquiries should be directed to Gabriel Mussio (713-247-3232).

4.0 LIST OF AUTHORIZED CONTRACTORS

- A. As of the date specified in paragraph 3.0.A., all contractors listed in paragraph 4.0.B were licensed in the State of Texas for this type of work. Authorized Contractors must maintain their license to be on this list.
- B. Authorized Contractors:
 - 1. AAR, Inc., Randall Richardson, President, 6640 Signat Road, Houston, Texas 77041, 713-466-6800, Fax : 713-466-4234
 - 2. Abatement Incorporated, Alan Manring, CEO, 4111 Greenbriar, Suite D, Stafford, Texas 77477, 281-265-0202, Fax : 281-265-4968
 - 3. AMX Environmental, Ltd., Tony Ross, CEO, 8701 Gulf Freeway, Houston, Texas 77017, 713-378-9911, Fax : 713-378-9922

**LIST OF PREQUALIFIED
ASBESTOS & LEAD ABATEMENT CONTRACTORS**

**CITY OF HOUSTON
STANDARD DOCUMENT**

4. ARC Abatement, Inc., Jerry Fields, Vice President, 6630 Roxburgh Drive, Suite 130, Houston, Texas 77041, 713-896-0668, Fax: 713-896-1772
5. Arrow Services, Inc., Kevin R. Davis, CEO, 410 Northville, Houston, Texas 77037-1229, 281-445-1246, Fax : 281-445-5865
6. Assured Environmental Quality, Inc., Pete Oliver, President, 7100 North Loop East, Suite A-18, Houston, Texas 77028, 713-672-8559, Fax: 713-672-8245
7. Basic Industries, Inc., Michael N. McGinnis, CEO, 3640 West 12th Street, Houston, Texas 77008-6008, 713-671-9036, Fax : 713-675-8691
8. Certified/LVI Environmental Systems, Inc., W.F. Wallace III, President, 10500 Telephone Road, Houston, Texas 77075, 713-991-0480, Fax : 713-991-2814
9. Cherry Environmental, Leonard Cherry, President, 6133 Selinsky, Houston, Texas 77048, 713-987-0000, Fax : 713-987-0622
10. Clark-Tech Environmental Systems, Inc., John P. Cochran, President, 1515 Globe, Houston, Texas 77034, 713-944-0497, Fax : 713-944-5006
11. Crochet & Borel Services, Inc., dba C & B Services, Mike McGee, Branch Mgr., 10515 Okanella, Suite 600, Houston, Texas 77041, 713-937-3473, Fax: 713-937-3466
12. CST Environmental, Inc., Subhas Khara, CEO, 14010 Interdrive West, Houston, Texas 77032, 281-449-5911, Fax : 281-449-6040
13. D & T Contracting, Inc., David Henry, 3511 Pinemont, Suite B4, Houston, Texas 77018, 877-245-3867, Fax : 713-688-7998
14. E.F.I. Services, Jesse Martinez, 2000 Smith Street, Houston, Texas 77002, 713-751-0111, Fax: 713-752-2002
15. GBS Environmental, Brian Wierwille, President, 993 Sheldon Road, Channelview, Texas 77530, 281-457-1611, Fax : 281-457-1664
16. Hazard Assessment Leaders, Inc. (dba HAL, Inc.), Helen Reddy, President, 5311 Petty Street, Houston, Texas 77007, 713-880-8264, Fax : 713-880-8279

17. I.C.E. Contractors, Inc., Diana I. Cross, CEO, 103 Gross Road, Dallas, Texas 75149, 972-288-8700, Fax : 972-288-8715
18. Inland Environments, Inc., Jed A. Landrey, CEO, P.O. Box 6751, Kingwood, Texas 77325-6751, 281-354-7500, Fax: 281-354-7540
19. J.T.B. Services, Jim Bulgier, President, 9026 Lambright, Houston, Texas 77075, 713-941-4141, Fax : 713-941-3405
20. KMAC Construction Services, Inc., Kevin McIntyre, President, 12019 Starcrest, San Antonio, Texas 78247, 210-599-6528, Fax: 210-599-2824
21. MARCOR Remediation, Inc., 8711 Burnet Road, Suite F62, Austin, Texas 78757, 512-377-4900, Fax: 512-377-4901
22. Olmos Abatement, Inc., Robert F. Lake, CEO, P.O. Box 200026, Austin, Texas 78720, 512-251-2277, Fax : 512-251-7707
23. Pacific Technologies, Inc., Joel T. Lytle, P.O. Box 4846, Boise, Idaho 83711, 208-344-8668, 800-311-8466, Fax: 208-342-2176
24. PfP Abatement Group, LLC, A. K. Deysarkar, Ph.D., CEO, 14227 Fern Street, Houston, Texas 77079, 281-759-3624, Fax: 281-759-6798
25. Southern Global Safety Services, Inc., Clare R. Hall, General Manager, 2986 County Road 180, Alvin, Texas 77511, 281-331-3667, Fax: 281-331-4236
26. Texas Environmental Control, Inc., Nancy Van Gilder, CEO, 4623 Steffani Lane, Houston, Texas 77041, 713-466-6717, Fax : 713-466-5160

END OF DOCUMENT

Document 00410A

BID FORM – PART A

To: **The Honorable Mayor and City Council of the City of Houston
City Hall Annex
900 Bagby Street
Houston, Texas 77002**

Project: Miscellaneous Large Diameter Water Line Improvements – Package 1
Project No.: WBS No. S-000900-0163-4

Bidder: _____
(Print or type full name of business entity, such as corporation, LLC,
etc)

OFFER

- A. Total Bid Price:** Having examined the Project location and all matters referred to in Bid Documents for the Project, we, the undersigned, offer to enter into a Contract to perform the Work for the Total Bid Price shown on the signature page of this Document
- B. Security Deposit:** Included with the Bid is a Security Deposit in the amount of 10 percent of the Total Bid Price subject to terms described in Document 00200 – Instructions to Bidders.
- C. Period for Bid Acceptance:** This offer is open to acceptance and is irrevocable for 90 days from Bid Date. That period may be extended by mutual written agreement of the City and Bidder.
- D. Addenda:** All Addenda have been received. Modifications to Bid Documents have been considered and all related costs are included in the Total Bid Price.
- E. Bid Supplements:** The following documents are attached:
 - Security Deposit (*as defined in Document 00200 - Instructions to Bidders*)
 - Document 00450 - Bidder's Statement of MWSBE Status
 - Document 00452 - Contractor's Submission List - Fair Campaign Ordinance Form A
 - Document 00453 – Bidder's Statement of Residency
 - Document 00454 - Affidavit of Non-interest
 - Document 00455 - Affidavit of Ownership or Control
 - Document 00457 – Conflicts of Interest Questionnaire (CIQ)
 - Document 00460 – (POP 1) Pay or Play Acknowledgement Form
 - Document 00470 – Bidder's MWSBE Participation Plan
 - Document 00471 – Pre-bid Good Faith Efforts (*required if the goal in Bidder's Participation Plan–Document 00470 is lower than the Goal*).
 - Document 00472 – Bidder's Goal Deviation Request (*required if the goal in Bidder's Participation Plan–Document 00470 is lower than the Goal*).

Others as listed: Valid official letter from OBO with your designation as a
City or Local Business

CONTRACT TIME

- A.** If offer is accepted, Contractor shall achieve Date of Substantial Completion with Document 00520, Article 2.

**Document 00410B
BID FORM – PART B**

**1.0 TOTAL BID PRICE HAS BEEN CALCULATED BY BIDDER, USING THE FOLLOWING
COMPONENT PRICES AND PROCESS (PRINT OR TYPE NUMERICAL AMOUNTS):**

A. STIPULATED PRICE:

NOT APPLICABLE - \$0.00

(Total Bid Price; minus Base Unit Prices, Extra Unit Prices, Cash Allowances and All Alternates)

B. BASE UNIT PRICE TABLE:

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
B.1 - All Locations						
1	01502S	Project Mobilization	LS	1	\$100,000.00 ⁽¹⁾	\$100,000.00 ⁽¹⁾
2	01562	Tree and plant protection	LS	1	\$20,000.00 ⁽¹⁾	\$20,000.00 ⁽¹⁾
<u>TOTAL BASE UNIT PRICES FOR ALL LOCATIONS</u>					<u>\$120,000.00</u>	

B.2 - Minute Maid Parking Lot

GENERAL ITEMS

1	01502S	Work Order Mobilization	LS	1	\$20,700.00 ⁽¹⁾	\$20,700.00 ⁽¹⁾
2	01555S	Traffic control and regulation 1	LS	1		
3	01555S	Flagmen 1	LS	1		
4	01555	Install low profile concrete barriers	LF	1,300		
5	01555	Remove low profile concrete barriers	LF	1,300		
6	01570	Filter Fabric Fence	LF	1,440		
7	01570	Inlet Protection Barrier	LF	200		
8	02105	Preparatory work for sampling and analysis on Potentially Petroleum Contaminated Areas (PPCA) 1	LS	1		
9	02120	Offsite transportation and disposal of non-hazardous category I soil	CY	4,360		
10	02120	Offsite transportation and disposal of contaminated ground water	Gal	64,500		
11	02260	Trench Safety System for Trench Excavation	LF	1,146		

PAVING ITEMS

12	02221	Remove and dispose reinforced concrete pavement with or without asphalt overlay (all depths)	SY	475		
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Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
13	02221	Remove and dispose asphalt pavement including subgrade (all depths)	SY	2,287		
14	02221	Remove and dispose concrete sidewalk	SY	222		
15	02336	Lime-for lime stabilized subgrade	Ton	14		
16	02336	Lime stabilized subgrade, 8-inch (6% lime by dry weight)	SY	661		
17	02741	Hot mix asphalt concrete pavement 2-inch	Ton	248		
18	02711	Hot mix asphalt base course, 8-inch	Ton	995		
19	02771	6-inch concrete curb (Monolithic)	LF	372		
20	02751	Reinforced Concrete Pavement, 10-inch thick	SY	521		
21	02752	Horizontal Dowel, 24-inch	EA	452		
22	02775	Sidewalk 4-1/2-inch thick	SF	1,987		
23	02752	Preformed Expansion Joint	LF	92		
STORM SEWER ITEMS						
24	02221	Remove existing type B inlet, BB inlet, type "A" grate inlet, type C manhole in PPCA	EA	2		
25	02221	Remove and dispose 15-inch diameter RCP storm sewer in PPCA	LF	36		
26	02221	Remove and dispose 18-inch diameter RCP storm sewer in PPCA	LF	17		
27	02631	15-inch diameter storm sewer by open cut (All depths)	LF	16		
28	02631	15-inch diameter storm sewer by open cut (All depths) in PPCA	LF	20		
29	02631	18-inch diameter storm sewer by open cut (All depths) in PPCA	LF	17		
30	02633	Proposed type B, type BB inlet, type "A" grate inlet in PPCA	EA	2		

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
WATER LINE ITEMS						
31	02511	24-inch diameter water line by Open Cut	LF	185		
32	02511/ 02105	24-inch diameter water line by Open Cut within the limits of PPCA	LF	697		
33	02511	24-diameter water line by open cut w/ restrained joint	LF	200		
34	02511/ 02505	24-diameter water line by open cut w/ restrained joint within the limits of PPCA	LF	347		
35	02517	24-inch diameter water line w/restrained joints in Tunnel	LF	140		
36	02522	24-inch Butterfly valve w/operator manhole	EA	1		
37	02522/ 02105	24-inch Butterfly valve w/operator manhole within the limits of PPCA	EA	4		
38	2524	2-inch AI/VR valve, vent piping w/ 3-bollards and access manway w/ service manhole	EA	1		
39	02513/ 02105	24-inch diameter wet connection within the limits of PPCA	EA	2		
40	02513	30-inch diameter wet connection	EA	1		
41	02516/ 02105	Cut, plug and abandon existing 24-inch diameter water line within the limits of PPCA	EA	2		
SIGNING AND STRIPPING ITEMS						
42	01554	Remove and replacement of signs	EA	2		
43	TxDOT 5011- 6002	Remove and Reset Precast Concrete Wheel Stops	EA	94		
44	02767	Thermoplastic Pavement Markings 24-inch wide White	LF	15		
45	02767	Thermoplastic Pavement Markings 12-inch wide White	LF	110		
46	02767	Thermoplastic Pavement Markings 6-inch wide White broken	LF	35		
47	02767	Thermoplastic pavement Marking symbol COMBINED ARROW	EA	2		
48	02767	Thermoplastic pavement Marking elongated word ONLY	EA	1		
49	Per dwg	Restripping parking spaces	LF	2,300		

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
CATHODIC PROTECTION						
50	16640	Cathodic Protection per Work Order	LS	1		
<u>TOTAL BASE UNIT PRICES FOR MINUTE MAID PARKING LOT</u>					\$ _____	

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
B.3 - Hillcroft at Bellaire Blvd						
GENERAL ITEMS						
1	01502S	Work Order Mobilization	LS	1	\$20,700.00 ⁽¹⁾	\$20,700.00 ⁽¹⁾
2	01555S	Traffic control and regulation 2	LS	1		
3	01555S	Flagmen 2	LS	1		
4	01555	Install low profile concrete barriers	LF	170		
5	01555	Remove low profile concrete barriers	LF	170		
6	01570	Filter Fabric Fence	LF	193		
7	01570	Inlet Protection Barrier	LF	80		
8	02105	Preparatory work for sampling and analysis on Potentially Petroleum Contaminated Areas (PPCA) 2	LS	1		
9	02120	Offsite transportation and disposal of non-hazardous category I soil	CY	330		
10	02120	Offsite transportation and disposal of contaminated ground water	Gal	354,500		
11	02260	Trench Safety System for Trench Excavation	LF	102		
PAVING ITEMS						
12	02221	Remove and dispose reinforced concrete pavement with or without asphalt overlay (all depths)	SY	187		
13	02221	Remove and dispose concrete sidewalk	SY	74		
14	02336	Lime-for lime stabilized subgrade	Ton	4		
15	02336	Lime stabilized subgrade, 8-inch (6% lime by dry weight)	SY	221		
16	02771	6-inch concrete curb (Monolithic)	LF	114		
17	02751	Reinforced Concrete Pavement, 10-inch thick	SY	204		
18	02752	Horizontal Dowel, 24-inch	EA	197		
19	02752	Preformed Expansion Joint	LF	38		

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
20	02775	Sidewalk 4-1/2-inch thick	SF	490		
21	02775	Wheer Chair Ramp with detectable warning surface, complete in place	SY	175		
WATER LINE ITEMS						
20	02511/ 02105	20-inch diameter water line by Open Cut within the limits of PPCA	LF	8		
21	02511/ 02505	24-diameter water line by open cut w/ restrained joint within the limits of PPCA	LF	94		
22	02517/ 02105	24-inch diameter water line w/restrained joints in Tunnel within the limits of PPCA	LF	198		
23	02522/ 02105	24-inch Butterfly valve w/operator manhole within the limits of PPCA	EA	1		
24	02524/ 02105	2-inch AI/VR valve, vent piping w/ 3-bollards and access manway w/ service manhole within the limits of PPCA	EA	1		
25	02525/ 02105	12-inch x 6-inch tapping sleeve and valve within the limits of PPCA	EA	1		
26	02400	Tunnel Shafts for 24-inch water line (include excavation, disposal of excavated materials, ground support system, backfilling and clean up) (for all shafts collectively) within the limits of PPCA	LS	1		
27	02513/ 02105	20-inch diameter wet connection within the limits of PPCA	EA	2		
28	02513/ 02105	24-inch diameter wet connection within the limits of PPCA	EA	2		
29	02516/ 02105	Cut, plug and abandon existing 20-inch diameter water line within the limits of PPCA	EA	1		
30	02516/ 02105	Cut, plug and abandon existing 24-inch diameter water line within the limits of PPCA	EA	2		
31	02520/ 02105	6-inch diameter fire hydrant branch by open cut within the limits of PPCA	LF	4		
32	02520/ 02105	Fire hydrant assembly , all depth; within the limits of PPCA	EA	1		
33	02520	Remove and salvage existing fire hydrant & deliver to the City maintenance facility	EA	1		

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
SIGNING AND STRIPPING ITEMS						
34	02767	Thermoplastic Pavement Markings 24-inch wide White	LF	30		
35	02767	Thermoplastic Pavement Markings 12-inch wide White	LF	25		
36	02767	Thermoplastic Pavement Markings 6-inch wide White broken	LF	70		
CATHODIC PROTECTION						
37	16640	Cathodic Protection per Work Order	LS	1		
<u>TOTAL BASE UNIT PRICES FOR HILLCROFT AND BELLAIRE</u>					\$	

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
B.4 - Hunting Bayou at I-10						
GENERAL ITEMS						
1	01502S	Work Order Mobilization	LS	1	\$20,700.00 ⁽¹⁾	\$20,700.00 ⁽¹⁾
2	01555S	Traffic control and regulation 3	LS	1		
3	01555S	Flagmen 3	LS	1		
4	01570	Filter Fabric Fence	LF	180		
5	01570	Rock Filter Dam Type 3	LF	50		
6	01570	Inlet Protection Barrier	LF	20		
7	01575	Stabilized construction exit	SY	222		
8	02260	Trench Safety System for Trench Excavation	LF	136		
9	02315	Restoring bayou to the original condition that include compaction and grading	LF	50		
10	02922	Sodding	SY	3,400		
WATER LINE ITEMS						
11	02511	42-diameter water line by open cut w/ restrained joint	LF	136		
12	02517	42-inch diameter water line w/restrained joints in Tunnel	LF	255		
13	02524	4-inch AI/VR valve assembly, including 60-inch service manhole w/ vent piping and 3 bollards	EA	1		
14	02082/ 02524	Access manway with service manhole	EA	1		
15	16640	Cathodic Protection Systems	LS	1		
16	02400	Tunnel Shafts for 42-inch water line (include excavation, disposal of excavated materials, ground support system, backfilling and clean up) (for all shafts collectively)	LS	1		
17	02513	42-inch diameter wet connection	EA	2		
18	02221	Remove and dispose 42" water line	LF	150		

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
19	02221	Remove and dispose existing 42-inch waterline supporting structure (to include concrete bents & columns or piles)	LS	1		
20	02516	Cut, plug and abandon existing 42-inch diameter water line	EA	4		
CATHODIC PROTECTION						
21	16640	Cathodic Protection per Work Order	LS	1		
TOTAL BASE UNIT PRICES FOR HUNTING BAYOU AT I-10					\$	

B.5 - Belfort Ave and Knight Rd						
GENERAL ITEMS						
1	01502S	Work Order Mobilization	LS	1	\$20,700.00 ⁽¹⁾	\$20,700.00 ⁽¹⁾
2	01555S	Traffic control and regulation 5	LS	1		
3	01555S	Flagmen 5	LS	1		
4	01555	Install low profile concrete barriers	LF	50		
5	01555	Remove low profile concrete barriers	LF	50		
6	01570	Inlet Protection Barrier	LF	30		
7	02922	Sodding	SY	60		
8	02317S	Exploratory Excavation	EA	1		
WATER LINE ITEMS						
9	02530	External reinforcement by post-tension tendons	EA	1		
TOTAL BASE UNIT PRICES FOR BELLFORT AND KNIGHT					\$	

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
B.6 - West Bellfort Ave at US-59						
GENERAL ITEMS						
1	01502S	Work Order Mobilization	LS	1	\$20,700.00 ⁽¹⁾	\$20,700.00 ⁽¹⁾
2	01555S	Traffic control and regulation 4	LS	1		
3	01555S	Flagmen 4	LS	1		
4	01555	Install low profile concrete barriers	LF	580		
5	01555	Remove low profile concrete barriers	LF	580		
6	01570	Inlet Protection Barrier	LF	90		
7	02105	Preparatory work for sampling and analysis on Potentially Petroleum Contaminated Areas (PPCA) 3	LS	1		
8	02120	Offsite transportation and disposal of non-hazardous category I soil	CY	740		
9	02120	Offsite transportation and disposal of contaminated ground water	Gal	217,000		
10	02260	Trench Safety System for Trench Excavation	LF	173		
PAVING ITEMS						
11	02221	Remove and dispose reinforced concrete pavement with or without asphalt overlay (all depths)	SY	711		
12	02336	Lime-for lime stabilized subgrade	Ton	13		
13	02336	Lime stabilized subgrade, 8-inch (6% lime by dry weight)	SY	573		
14	02771	6-inch concrete curb (Monolithic)	LF	150		
15	02751	Reinforced Concrete Pavement, 10-inch thick	SY	218		
16	02752	Reinforced Concrete Pavement, 16-inch thick	SY	324		
17	02752	Horizontal Dowel, 24-inch	EA	459		
18	02752	Preformed Expansion Joint	LF	96		
19	02772	6-inch Concrete Median or Directional Island	SY	201		

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
STORM SEWER ITEMS						
20	02222	Remove top 2- feet of existing storm sewer manhole, grout fill and abandon in place in PPCA. Return frame and cover to the City of Houston	EA	1		
WATER LINE ITEMS						
21	02511/ 02505	24-diameter water line by open cut w/ restrained joint within the limits of PPCA	LF	173		
22	02551	Sliplining 30-inch water line with 24-inch water line	LF	390		
23	02551	Dewatering existing 30-inch waterline	LF	390		
24	02522/ 02105	24-inch Butterfly valve w/operator manhole within the limits of PPCA	EA	1		
25	02082/ 02524/ 02105	Access manway with service manhole within the limits of PPCA	EA	1		
26	02400	Tunnel Shafts for sliplining 24-inch water line in 30-inch water line (include excavation, disposal of excavated materials, ground support system, backfilling and clean up) (for all shafts collectively) within the limits of PPCA	LS	1		
27	02513/ 02105	24-inch diameter wet connection within the limits of PPCA	EA	1		
28	02513/ 02105	30-inch diameter wet connection within the limits of PPCA	EA	1		
29	02221/ 02105	Remove and dispose 30" water line within the limits of PPCA	LF	173		
SIGNING AND STRIPING ITEMS						
30	02767	Thermoplastic Pavement Markings 24-inch wide White	LF	37		
31	02767	Thermoplastic Pavement Markings 12-inch wide White	LF	200		
32	02767	Thermoplastic Pavement Markings 6-inch wide White broken	LF	115		
CATHODIC PROTECTION						
33	16640	Cathodic Protection per Work Order	LS	1		
TOTAL BASE UNIT PRICES FOR BELLFORT AT US-59					\$	

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
B.7 - Kelley St						
GENERAL ITEMS						
1	01502S	Work Order Mobilization	LS	1	\$20,700.00 ⁽¹⁾	\$20,700.00 ⁽¹⁾
2	01555S	Traffic control and regulation 6	LS	1		
3	01555S	Flagmen 6	LS	1		
4	01570	Filter Fabric Fence	LF	384		
5	01570	Reinforced filter fabric barrier	LF	450		
6	01570	Inlet Protection Barrier	LF	20		
7	02519	Leak Detection including mobilization	LS	1		
PAVING ITEMS						
8	02221	Remove and dispose reinforced concrete pavement with or without asphalt overlay (all depths)	SY	27		
9	02336	Lime-for lime stabilized subgrade	Ton	1		
10	02336	Lime stabilized subgrade, 8-inch (6% lime by dry weight)	SY	27		
11	02751	Reinforced Concrete Pavement, 10-inch thick	SY	27		
12	02752	Horizontal Dowel, 24-inch	EA	21		
13	02752	Preformed Expansion Joint	LF	5		

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
WATER LINE ITEMS						
14	02519	Internal water line rehabilitation	EA	2		
15	02519	External water line rehabilitation	EA	2		
16	02519	Pipe dewatering	LF	3800		
17	02514S	Disinfection preparation of existing water line	LF	500		
18	02524S	Remove and replace 4-inch air valve assembly	EA	2		
19	02519	Remove and replace access manway flange	EA	2		
TOTAL BASE UNIT PRICES FOR KELLEY ST					\$	_____

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
B.8 - Meter Station near Sims Bayou						
GENERAL ITEMS						
1	01502S	Work Order Mobilization	LS	1	\$20,700.00 ⁽¹⁾	\$20,700.00 ⁽¹⁾
2	01570	Filter Fabric Fence	LF	368		
3	01570	Reinforced filter fabric barrier	LF	50		
4	01575	Stabilized construction exit	SY	111		
5	02260	Trench Safety System for Trench Excavation	LF	187		
6	02821	Remove 6' high chain link fence	LF	80		
7	02821	Remove 8' high chain link fence	LF	74		
8	02821	Install 6' high chain link fence	LF	114		
9	02821	Install 8' high chain link fence	LF	40		
10	02821	6'x10' Gate install	EA	1		
11	02922	Sodding	SY	0		
PAVING ITEMS						
12	02221	Remove existing conc. Foundation	CY	55		
13	02221	Remove existing concrete Pipe support	CY	4		
14	01110	Proposed concrete foundation, concrete slab with and without grade beam, concrete pad and concrete pipe support.	LS	1		
WATER LINE ITEMS						
15	02511	24-diameter water line by open cut w/ restrained joint	LF	76		
16	02511	30-diameter water line by open cut w/ restrained joint	LF	111		
17	02522	24-inch diameter Butterfly valve	EA	2		
18	02522	30-inch diameter Butterfly valve	EA	1		

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
19	02522/15138	30-inch diameter Butterfly valve w/electric valve actuator	EA	1		
20	02524	2-inch diameter combination air valve (air release and vacuum relief valve)	EA	2		
21	02523/15047	24 -inch diameter PRV w/Metering	EA	1		
22	Per Dwg	30-inch diameter check valve	EA	1		
23	02513	30-inch diameter wet connection	EA	1		
24	02513	36-inch diameter wet connection	EA	1		
25	02221	Remove and dispose 24" water line	LF	69		
26	02221	Remove and dispose 30" water line	LF	99		
27	02221	Remove and dispose 36" water line	LF	10		
ELECTRICAL WORKS						
28	1270S	Electrical	LS	1		
29	1270S	Instrumentation & Control (SCADA)	LS	1		
<u>TOTAL BASE UNIT PRICES FOR SIMS BAYOU METERING STATION</u>					\$	

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
C. UNIT PRICE ITEMS FOR EXTRA ITEMS						
EU.1	02317	Extra 6-inch over excavation of trench bottom	LF	185	\$4.00 ⁽²⁾	
EU.2	02317	Extra 6-inch over excavation of trench bottom in PPCA	LF	94	\$10.00 ⁽²⁾	
EU.2	02318	Extra hand excavation	CY	70	\$20.00 ⁽²⁾	
EU.3	02318	Extra hand excavation in PPCA	CY	38	\$25.00 ⁽²⁾	
EU.3	02318	Extra machine excavation	CY	145	\$20.00 ⁽²⁾	
EU.4	02318	Extra machine excavation in PPCA	CY	68	\$25.00 ⁽²⁾	
EU.4	02318	Extra placement of backfill material	CY	500	\$7.00 ⁽²⁾	
EU.5	02318	Extra placement of backfill material in PPCA	CY	250	\$15.00 ⁽²⁾	
EU.5	02501	Extra ductile iron compact fittings in place	Ton	1	\$1,800.00 ⁽²⁾	
EU.6	02501	Extra ductile iron compact fittings in place in PPCA	Ton	1	\$1,900.00 ⁽²⁾	
EU.6	02534	Extra sanitary sewer service line reconnection	EA	5	\$500.00 ⁽²⁾	
EU.7	02534	Extra sanitary sewer service line reconnection in PPCA	EA	3	\$600.00 ⁽²⁾	
EU.7	02221	Extra Remove and dispose of 54-inch Storm Sewer	LF	20	\$100.00 ⁽²⁾	
EU.8	02631	Extra 54-Inch Storm Sewer by Open Cut	LF	20	\$200.00 ⁽²⁾	
EU.9	02221	Extra Remove and Dispose 42-Inch Storm Sewers	LF	12	\$40.00 ⁽²⁾	
EU.10	02631	Extra 42-Inch Storm Sewer by Open Cut	LF	12	\$120.00 ⁽²⁾	
EU.11	02317	Extra Placement & Removal of Granular Backfill Material (3/4-Inch Crushed Limestone or Other Approved Material)	CY	7	\$35.00 ⁽²⁾	
EU.12	02519	Extra Internal Water Line Rehabilitation	EA	3	\$6,000.00 ⁽²⁾	
EU.13	02519	Extra External Water Line Rehabilitation	EA	3	\$5,000.00 ⁽²⁾	

Item No.	Spec Ref	Item Description	Unit Measure	Unit Quantity	Unit Price (this column controls)	Total in Figures
EU.14	02221	Extra Remove & Dispose of Concrete Pavement (All Thickness, w/ or w/out Asphalt, Including Base & Subgrade, w/ or w/o Curb, All Depth)	SY	68	\$5.00 ⁽²⁾	
EU.15	02751	Extar Reinforced Concrete Pavement 10-Inch Thick	SY	68	\$72.00 ⁽²⁾	
EU.16	02752	Extra Street Pavement Expansion Joint with Load Transfer	LF	14	\$8.00 ⁽²⁾	
EU.17	02752	Extra Horizontal Dowel, 24-Inch	EA	53	\$7.00 ⁽²⁾	
EU.18	02337	Extra Lime-for lime stabilized subgrade	TON	2	\$130.00 ⁽²⁾	
EU.19	02337	Extra Lime/Fly-Ash Stabilized Subgrade 8-Inch	SY	68	\$15.00 ⁽²⁾	
EU.20	02221	Extra Remove and Dispose of Concrete Curb and Gutter	LF	100	\$2.75 ⁽²⁾	
EU.21	02771	Extra 6-Inch Concrete Curb (monolithic)	LF	100	\$5.00 ⁽²⁾	
EU.25	01502	Demobilization/Remobilization – Level 1	LS	1	\$15,000.00 ⁽²⁾	
EU.26	01502	Demobilization/Remobilization – Level 2	LS	1	\$25,000.00 ⁽²⁾	
TOTAL EXTRA UNIT PRICES					\$	

D. UNIT PRICE TABLE FOR CASH ALLOWANCES					
CA.1	01110	Street Cut Permit	CA	1	\$4,800.00
CA.2	01110	HCFC D Permit	CA	1	\$5,000.00
CA.3	01110	Street Light Pole adjustment and/or relocations	CA	1	\$5,000.00
TOTAL CASH ALLOWANCES					\$14,800.00

SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Summary of the Work including work by the City, City-furnished Products, Work Sequence, Future Work, Contractor use of Premises.

1.02 PROJECT DESCRIPTION

- A. Surface Water Transmission Program (SWTP) consists of major improvements to transmission system to convert from primarily groundwater to surface water in order to comply with the Harris-Galveston Subsidence District's (HGSD) regulatory plan. Program includes transmission and distribution of surface water and associated consolidation of groundwater plants in the City.
- B. The project is construction of water line ranging from 24-inch to 84-inch at seven (7) different locations. Site 1 includes the construction of 24-inch and 30-inch water line near Minute Maid Park. Site 2 includes the construction of 24-inch water line at the intersection of Bellaire Boulevard and Hillcroft Avenue. Site 3 involves the construction of 42-inch water line at Hunting Bayou and I-10. Site 4 includes externally reinforcing one pipe section of a 42-inch water line at West Bellfort Ave and Knight Rd. Site 5 involves the construction of a 24-inch water line and sliplining of 24-inch water line inside 30-inch water line on West Bellfort at US Highway 59. Site 6 includes leak detection of an 84-inch water line and determining exact rehabilitation method, either internal, external or both, along Kelley St. Site 7 involves the construction of new meter station near Sims Bayou.

1.03 WORK COVERED BY CONTRACT DOCUMENTS

This work will include, but not limited to, the following:

A. Pavement:

1. Remove approximately 3,687 S.Y. of existing reinforced concrete pavement with or without asphalt surface and/ or asphalt pavement.
2. Construct approximately 970 S.Y. of 10 inch reinforced concrete pavement, 324 S.Y. of 16 inch reinforced concrete pavement along with 1482 S.Y. of 8-inch lime stabilized subgrade (6% by dry weight) and 636 LF of 6-inch concrete curbs.
3. Excavation and fill for roadway construction.
4. Installation of sod from back of curb to the right-of-way.

B. Storm Sewer:

1. Remove existing storm sewer pipes ranging from 15-inch to 42- inches diameter
2. Construct reinforced concrete pipes ranging from 15-inch to 18-inches diameter.

3. Remove and replace Inlets (Type A grate inlet and B inlet).
 4. All flow lines shall be verified prior to ordering fabrication of the inlets and manholes.
- C. Large Diameter Water Line:
1. Construct approximately 2,023 L.F of water line ranging from 24-inch to 42-inch by open cut construction (within and outside the limits of PPCA).
 2. Install approximately 644 L.F of water line ranging from 24-inch to 48-inch diameter in tunnel (within and outside the limits of PPCA).
 3. Construct approximately 390 L.F of 24-inch water line by sliplining in 30-inch water line.
 4. All large diameter water line quantities have been accounted as open-cut and tunneling construction method. Contractor must review the construction documents carefully before bidding.
 5. Construction of 7 Butterfly Valves ranging from 24-inch to 30-inch diameter with Operator Manholes.
 6. Construction of 2 2-inch Air Input Vacuum Release Valve with access manway with service manhole.
 7. Construction of 1 4-inch Air Input Vacuum Release Valves with service manhole.
 8. Construction of 2 access manways with service manhole.
 9. Installation of the Cathodic Protection Systems.
 10. Installation of 1 24-inch PRV with metering and flow controller.
 11. Remove approximately 501 feet of exiting waterlines ranging from 24-inch to 42-inch.
 12. Installation of an external reinforcement by post-tension tendon system on an existing 48-inch PCCP water line.
 13. Leak detection on an 84-inch water line to determine rehabilitation method, either external or internal. Limits of excavation will be determined when leak location has been found.
 14. Remove and replace a 4-inch Air Input Vacuum Release Valve and an Access Manway Flange for leak detection.
 15. Sims Bayou Metering Station - Electrical & Instrumentation/Control Work:
 - A. Repair existing conduit for East Metering Station and provide new power and control wiring for new (West) Metering Station from Pump House Building to location of existing East Metering Station prior to any demolition of new (West) Metering Station.
 - B. Provide demolition of existing electrical and instrumentation equipment, conduit, and wiring.
 - C. Provide electrical grounding for new gates and fencing around station.

- D. Provide new electrical feeder to metering station area along with 15 KVA step-down transformer for new 3 phase 120/208 V service for new metering station equipment.
 - E. Installation for new West Metering Station shall include control panel with SCADA terminals, electrical actuator for butterfly valve (supplied with valve), pressure transducer with local readout, metering pressure reducing valve with controller, site lighting and chlorine analyzer along with related enclosures, panels, wiring and conduit.
 - F. Provide SCADA programming revision for new Metering Station to proper operate and monitor metering station.
- 16. Payment for removing and salvaging existing fire hydrant also includes removal of existing gate valve on the fire hydrant branch. Return salvaged fire hydrants to the City's Maintenance Quadrant Stock yard.
 - 17. Removal of all abandoned water valves and removal of existing water valves on the existing water line which is being abandoned is not a separate pay item, incidental to the cost of proposed water line.
 - 18. Quantities for water line with restrained joints is accounted for minimum limits/length as called out in the profile sheets. There will be no quantity/price adjustments for any extra length of restrained joint placed in the field. As a minimum of 3 sites we require external concrete thrust blocks with different dimensions and cubic yard as have been called for on plans. Payment for thrust block is incidental to the cost of the waterline and is not a separate pay item.
 - 19. For wet connections – no separate pay for removal of portion of existing water line, incidental to the unit price of wet connection, complete in place.
 - 20. Removal and disposal of portions of existing asbestos cement (AC) water line in conflict with the proposed storm sewer construction may be necessary as shown in the plans. Removal and disposal of AC water lines shall be in conformance with specification sections 00041, 02221 and 13281.
- D. Miscellaneous:
- 1. No separate pay item for providing temporary support/bracing of existing utilities while doing proposed construction. Contractor shall observe all COH Ordinances, TCEQ regulations and OSHA guidelines during construction activities.
 - 2. Mobilizing and setting traffic control devices and installing temporary signalization.
 - 3. Erect project identification signs as specified in specification Section 01580 and detail included in the construction drawings, as directed by the City of Houston Project Manager. No separate pay for project identification signs, incidental to mobilization cost.
 - 4. Removal of existing abandoned CenterPoint Energy gas lines will be necessary at locations where they are in conflict with the proposed improvements.

5. Providing Tree and Plant Protection, and implementing Storm Water Pollution Prevention Plan (SW3P).
6. Provide sidewalk and/or checker plate as per Tree Protection Plan drawings.
7. Maintain and place SWPPP devices during construction in accordance with guidelines established by Best Management Practices, TCEQ and EPA. Contractor shall submit all forms to agencies prior to beginning construction activities according to documents herein.
8. Payment for the construction of Proposed Concrete foundation, with or without grade beam, concrete pad and concrete pipe support for metering station will be on lump sum basis. Payment will include labor, equipment, material and hauling costs as shown on the drawings.
9. No separate pay item for routing produced groundwater, surface water, or chlorinated flush water to City of Houston storm sewer inlets or manholes. Produced water will NOT be allowed in any TxDOT drainage facilities.

1.04 DEFINITION

- A. Large Diameter Water Lines: water lines 24-inch in diameter and larger. References to large diameter water lines shall apply to pipe, valves and appurtenances 24-inch and larger.
- B. Small Diameter Water Lines: water lines 20-inches in diameter and smaller. Unless otherwise noted in the Contract Documents, requirements pertaining to large diameter water lines do not apply to pipe valves and appurtenances 20-inches in diameter and smaller.

1.05 CASH ALLOWANCE

- A. Include the following specific Cash Allowances in the Contract Price under provision of Document 00700 – General Conditions, Paragraph 3.11.
 1. Street Cut Permit
 2. Flood Plain Management Permit
 3. Harris County Flood Control District Permit
 4. Street Light Pole adjustment and/or relocations

City Contractor is responsible for obtaining the above mentioned permits prior to any construction activities. In document 00410B of this package, budgets have been allocated as cash allowances for these purposes. TPDES/TCEQ general permit (if required) is not a separate pay item and is incidental to the cost of this project.

1.06 INCENTIVE ALLOWANCES

- A. Complete entire work and site restoration within calendar days from the date of commencement as defined in document 00700 – General Conditions. Failure to meet

calendar day completion deadline will result in liquidated damages in accordance with document 00800 - Supplementary Conditions.

1.07 CITY FURNISHED PRODUCTS

- A. Items furnished by City for installation and final connection by Contractor.
 - 1. Water Meters – Only if the existing water meters are damaged
- B. Contractor's responsibilities:
 - 1. Contractor will supply all new construction materials as outlined in Schedule of Unit Price Work, Document 00410B.
 - 2. Arrange and pay for product delivery to the site.
 - 3. Receive and unload products at the site; jointly with the City, inspect for completeness or damage.
 - 4. Handle, store, install and finish products.
 - 5. Repair or replace damaged items.

1.08 WORK SEQUENCE

- A. Perform critical locates per Drawings within 14 days from Notice to Proceed. Field verify dimensions and conditions before commencing work. Report any discrepancies to Project Manager before commencing work. Submit documentation of work completion to the Project Manager.
- B. Due to overall project complexity and numerous active utility interface requirements, submit a sequence of construction for review by Project Manager. Proposed sequence of construction shall address proposed method and timing of major construction activities. Refer to Section 01326 – Construction Schedule (Bar Chart) for specific details.

1.09 WORKS BY CITY

- A. The Water Maintenance Division will perform the following work without cost to the contractor:
 - 1. Operating water line valves. **VALVES (including new valves connected to existing water lines that are in service) ARE TO BE OPERATED ONLY BY PUBLIC WORK – UTILITY MAINTENANCE BRANCH PERSONNEL.**
 - 2. Operate valves for disinfection, hydrostatic testing, wet connections, shutdowns, and placing lines in service.

1.10 COORDINATION OF WORK

- A. Coordination of the Work: Refer to Section 01312 – Coordination and Meetings.

- B. Schedule the Work with any other contractors of any trade of discipline working adjacent to the project site prior to and during construction.
- C. Schedule construction operations with City Project Manager, Traffic Management, Maintenance Division, and private utilities.
- D. Notify the Harris County Flood Control District's Property Management Department in writing at least 48 hours prior to construction. Submit the HCFCD 48-hour Preconstruction Notification form and a copy of the approved construction drawings to HCFCD, 9900 Northwest Freeway, Houston, Texas 77092, Attn: Property Management Dept., by hand delivery or FAX to 713-684-4212. See Exhibit A at the end of Section 01110 for HCFCD Notification Form.
- E. Schedule testing and inspection of cathodic protection system and protective coating for pipe and valves with the City's independent consultant. Contact [REDACTED] at [REDACTED].
- F. Tunnel at Crossing of CNP 12-inch and 14-inch gas lines along Glen Valley, Belfort Street, Broadway Street and Sims Bayou:
 - 1. Tunnel crossing shall be installed using a Tunnel Boring Machine (TBM) with full shielding and closed face capabilities. Tunnel crossing is through soil strata with varying characteristics. Comply with requirements of Section 2425(LD) – TUNNEL EXCAVATION AND PRIMARY LINER for using TBM.
 - 2. Unless approved otherwise by Project Manager, perform tunneling from southern limit of tunnel and work northward or from eastern limit of tunnel and work westward.
 - 3. Provide specific instrumentation monitoring plan, in accordance with Section 02425(LD) – TUNNEL EXCAVATION AND PRIMARY LINER. Submit monitoring plan and locations of instrumentation to Project Manager for approval.
 - 4. Dewatering of construction of the tunnel shafts and tunnel crossing may require the use of deep well systems or educator or ejector type well systems. Refer to geotechnical reports in Section 00320.
 - 5. Obtain Harris County Public Infrastructure ROW permit prior to performing any work within HCFCD ROW. Submit HCFCD 48-hour Preconstruction Notification as indicated in Paragraph 1.10.D above.

1.11 CONTRACTOR USE OF PREMISES

- A. Comply with procedures for access to site and Contractor's use of right-of-way as specified in Section 01145 - Use of Premises.
- B. Construction operations limited to City's right-of-way or easements provided by City of Houston right-of-way.
- C. Utility Outages and Shutdown: Provide notification to City and private utility companies (when applicable) a minimum of 48 hours, excluding weekends and holidays, in advance of required utility shutdown. Coordinate all work as required.

- D. Work on proposed storm sewer and water lines shall be done to grades, elevations and locations as shown on the drawings.
- E. Prevent overstress of any structure, and any part or member of it, during construction. This applies to existing work and structures affected by operations. Check effect of operations in this regard, and provide temporary supports and connections required to assure safety and stability of both new and existing work and to prevent overstress of any part.
- F. Plan activity schedule and extend full cooperation to other contractors who have responsibilities either concurrent with, proceeding or following this Contractor's time along work site. Ensure availability of access, availability of selected portions of this area to others and provide appropriate information for planning purposes to other contractors.
- G. Restore and sod all non-paved areas that are damaged during construction as per specification Section 02922 - Sodding. The sodding should be placed for one (1) foot from back of median curb, and from back of curb to the right-of-way for the entire limits of the project, except those special areas of Tree and Plant Protection as indicated on the construction drawings.
- H. Traffic Control:
 - 1. Traffic control plan responsive to Texas Manual on Uniform Traffic Control Devices (TMUTCD) and sealed by a Registered Professional Engineer is incorporated into the drawings. If traffic control will be implemented without modification to plans provided, submit letter confirming that decision. If traffic control will be modified from what is shown, submit traffic control plan in conformance with TMUTCD and sealed by a Registered Professional Engineer.
 - 2. Traffic control provided is based on the assumption there is no conflict with traffic control from separate projects within construction limits. Coordinate work to prevent traffic control conflicts or submit revised traffic control plans sealed by Registered Professional Engineer and conformed to TMUTCD at no additional cost. Submit traffic control plan to Project Manager for approval.
 - 3. For temporary pavement, provide necessary backfill, subgrade, base and surface in accordance with the Traffic Control Plan and continuously maintain, as directed by Project Manager.
- I. Work will be allowed which pertains to any tunneling operation 24 hours per day, provided above ground activities do not conflict with provisions of City of Houston Code of Ordinances, Section No. 40-28 and work does not occur on a Sunday or holiday without prior written approval. No night work shall occur in residential areas. A non-inclusive list of work pertaining to tunneling operation is as follows:
 - 1. Tunnel excavation and incidental work such as muck removal and hauling, ventilation, lighting, survey control of tunnel line and grade, etc.
 - 2. Tunnel primary liner.
 - 3. Ground water control and ground stabilization.
 - 4. Pipe installation.

5. Tunnel grouting.

*Project Manager will answer all questions where confusion may exist as to whether any such work pertains to tunneling operation.

- J. Implement groundwater control methods, while maintaining accessibility to driveways and cross streets.
- K. Implement temporary drainage facilities while maintaining existing capacities of channels, storm sewers, and inlets.
- L. Maintain local driveway access to residential and commercial properties adjacent to work areas. Provide temporary driveway access to driveways in accordance with Section 01555 – Traffic Control and Regulation and Section 01145 – Use of Premises. Schedule work with business owners and residents.
- M. City’s Utility Maintenance Division is not bound to assist the Contractor in locating existing utility during construction. Contractor must verify location of existing utility lines prior to commencement of pipe laying operations.
- N. Working multiple and separate crews during construction is allowed, as approved by Project Manager.
- O. Field Office:
 - 1. A field office is not required on this project.

1.12 STREET CUT ORDINANCE

- A. Excavations on or under pavement in the City’s right of way must have a permit. Comply with City of Houston,
- B. Ordinance No. 2000-1115, an ordinance amending Chapter 40 of the Code of Ordinances, Houston, Texas, relating to excavating in the Public right of way.

Schedule of Permit Application Fee*

Initial Application Fee:

Tunneling, Jacking, and Boring only	\$150.00
All other Methods of Excavation	\$200.00
Administration Fee	\$30.00

Permit Extension Application Fee:

Other than Steel Plate Temporary Surface	\$30.00
Steel Plate Temporary Surface	\$50.00
Data Entry Fee for Non-Electronic Submission (Per application)	\$55.00

*All fees/charges are non-refundable.

Comply with latest edition of street cut new pavement repair and pavement replacement details.

Contractor shall comply with requirements from Chapter 12 of the City of Houston Infrastructure Design Manual (dated July 2016), entitled “Street Cut Requirements”.

- C. The bid items for the cost of street cut pavement repair and replacement identified on the drawings are included in the Bid Form Part B (Document 00410 B).
- D. Obtain all required permits and signs prior to performing any methods of construction involving street excavation in the existing pavement.

1.13 WARRANTY

- A. Comply with warranty requirements in accordance with Document 00700 – General Conditions.

1.14 INTERPRETATION OF CONFLICTS

- A. If conflicts occur in Contract Documents, request interpretation before proceeding with work. Such requests shall first be preceded by a diligent investigation into Contract Documents. Contain evidence of such investigation in requests for interpretation.

1.15 ADDITIONAL CONDITIONS FOR SUBSTANTIAL COMPLETION

- A. In additions to requirements outlined in Document 00700 – General Conditions, for Contractor to be substantially complete with the work and call for inspection by Project Manager to confirm, the following special conditions must be met or completed:
 1. Hydrostatic testing and disinfection shall be completed and accepted by the Project Manager.
 2. All safety related work including pavement stripping, signing and signalization shall be completed.
 3. All safety related systems and equipment shall be installed, accepted by manufacturer's representative and approved for use.
 4. All yards and sprinkler systems have to be restored or repaired to pre-construction condition or better. Not a separate pay item incidental to the cost of the project.
 5. Transfer services.
 6. Complete report of all pay items.
 7. Contractor shall contact and notify the Engineer/Construction Project Manager no later than thirty (30) days after completion of the project to complete Texas Department of Licensing and Registration post construction inspection of pedestrian elements for Texas Accessibility Standards.
 8. All post TV inspection tapes/ DVDs shall be submitted for approval.
 9. "As-built mark-ups" of the construction drawings of all work performed within public rights-of-ways shall be provided to the Project Manager as part of the project close-out procedures.

1.16 GENERAL CONSTRUCTION NOTES

- A. Contractor shall give notice to all authorized inspectors, superintendents or persons in charge of private and public utilities or rights-of-way affected by his or her operations, prior to commencement of work.
- B. Notify the Utility Coordinating Committee at 1-800-669-8344 or 713-223-4567, and the City of Houston Department of Public Works and Engineering, Civil Construction via fax at 832-394-9620, at least 48 hours prior to commencement of work.
- C. Call the Traffic Management and Maintenance Division of the City of Houston Public Works and Engineering Department when work is scheduled near traffic signal conduits the City of Houston 713-881-3179 or 713- 803-3070. Call at least five working days in advance.
- D. Contractor shall coordinate with any other contractors of any trade or discipline working adjacent to the project site prior to and during construction.
- E. Contractor shall be responsible for adequately protecting existing structures, utilities, trees, shrubs, fences and other adjoining facilities. Any damaged irrigation/sprinkler systems caused by the contractor during construction within the project limits shall be replaced as incidental to the contract/project cost. All damages caused by contractor shall be repaired or replaced at the contractor's expense.
- F. Contractor shall comply with OSHA Regulations and State of Texas laws concerning excavation, trenching and shoring as specified in City of Houston Ordinance No. 87-1457.
- G. Contractor shall notify/inform all local businesses, home owners, property owners, schools, banks (located within the project limits), Houston Fire Department, Houston/Harris County EMS services, and Houston Police Department two (2) weeks prior to the start of construction.
- H. Contractor shall contact and coordinate with CenterPoint Energy at 713-207-2222 at least eight weeks in advance when work is scheduled for construction to arrange for overhead lines that are in conflict with the construction activity/ equipment to be deactivated or removed.
- I. Adequate drainage shall be maintained by contractor at all times during construction. All construction run-offs shall comply with the 2006 Standard of "Storm Water Management Handbook for Construction Activities" as prepared by Harris County/ HCFCD and the City of Houston. All in compliance with the Texas pollutant discharge elimination system requirements. Contractor shall be responsible for preventing debris from falling into the HCFCD ditches while doing any work.
- J. Contractor shall be responsible for removal of siltation in existing and proposed storm sewer systems that result from construction activities associated with this project. Not a separate pay item incidental to the cost of the project.
- K. The Contract drawings and the surveys upon which they are based are tied into the official City of Houston survey system in compliance with ordinance No. 69-1978. City of Houston

survey markers and monuments referenced have been included in the construction plan set.

1.17 EXISTING UTILITIES

- A. Underground utilities (public and private) exist in the vicinity of this project. While every effort has been made to show locations for existing utilities, they are approximate and other utilities may exist in the vicinity of this project which is not shown on these plans. The Consultant and the City do not warranty the accuracy and completeness of the existing utilities. The location and grades of existing utilities are either based on as-built drawings, Houston GIMS or survey information.
- B. Contractor shall field verify the location and elevation of all utilities prior to commencing construction or any excavation. Contractor shall field locate all un-metered fire lines, large water meters, and/or isolation valves before installing new water lines. No separate pay item is provided for this work. Contractor shall be responsible for any damage to the existing utilities and shall repair the damaged utilities to the existing condition or better with no additional cost.
- C. Profile(s) for existing private utilities and existing pipelines shown in the drawings are provided by the respective utility owners. These profile depths are approximate and not field verified. Contractor shall exercise caution while doing work in that vicinity.
- D. Public and private utility lines and customer service lines may exist that are not shown on the construction drawings. It shall be the contractor's responsibility to locate, maintain and protect the integrity of these lines. Hand excavation may be required.
- E. Existing utility lines less than 4-inch in diameter are not shown on the profile drawings but they do exist per plan. Contractor shall pre-locate as required.
- F. All private utilities should be relocated by private utility contractor. The contractor shall coordinate with the proper utility company and request them to relocate or divert any conflicts with proposed construction during construction.
- G. Contractor shall contact the utility coordinating committee at (713) 223-4567 or 1-800-669-8344 a minimum of 72 hours prior to construction to have main and service lines field located.
- H. Public utility service lines (water) are not shown on the drawings. Contractor shall anticipate that such service lines exist and repair them if damaged during construction. No separate pay will be made for repairs. The cost shall be incidental to the work.
- I. Do not interrupt existing water service. Proposed water lines shall be constructed and service transferred per City of Houston requirements prior to the commencement of any underground construction that may interfere with existing water service.
- J. Maintain existing water service and sanitary sewer service within construction area until construction of the new system is complete.
- K. Maintain existing storm drainage service within construction area until construction of the new system is complete.

1.18 WATER LINES

- A. This project shall be built by means of open-cut and tunneling as noted on the drawings.
- B. Water lines shall be constructed in accordance with current City of Houston specifications for large diameter water lines.
- C. All utilities present on the drawings are shown at approximate locations based on the best available information. The contractor shall field verify the exact locations prior to commencing construction. He or she shall be fully responsible for any or all damages caused by his or her failure to exactly locate and maintain these underground utilities, at no additional cost to the City of Houston.

1.19 STORM WATER

- A. Adequate drainage shall be maintained at all times during construction and any drainage ditch or structure disturbed during construction shall be restored to the satisfaction of the owning authority. All construction storm runoff shall comply with the final draft of the Storm Water Management Handbook for construction activities, as prepared by Harris County, HCFCD and the City of Houston in compliance with NPDES requirements.
- B. During any storm sewer and/or lead replacement, pull to the last full joint.
- C. Contractor shall be responsible for removal of siltation in existing and proposed storm sewer systems (if necessary) that result from construction activities associated with this project. Not a separate pay item incidental to the cost of the project.
- D. Contractor shall prepare a Storm Water Management Plan for the design and maintenance of temporary drainage facilities including inlets, channels, and storm sewers. The plan shall include the sizes and locations of existing and temporary facilities. The plan shall include detailed calculations of the capacities of the temporary facilities that equal or exceed the existing capacities in accordance to the Storm Water Management Handbook for construction activities, as prepared by Harris County, HCFCD and the City of Houston. No separate payment will be made for this plan. Not a separate pay item incidental to the cost of the project.

1.20 SANITARY SEWER

- A. The contractor is fully responsible for damages to the existing sanitary sewer facilities as a result of this project. Sanitary sewers shall be constructed in compliance with the latest city specifications for sewer construction, and tested as specified in the City test procedure or either liquid or air, including all amendments and revisions thereto. Embedment and backfill for sanitary sewers shall be placed in accordance with City of Houston standard drawing unless otherwise noted.
- B. Maintain service to all sewers during construction. Contractor is responsible for locating all sanitary sewer service laterals affected by construction. The city does not warranty the location or number or any sanitary leads shown in plans.
- C. If a damaged sanitary sewer line is being replaced as a result of this construction, the transfer of service stubs from existing to the proposed sanitary sewer must be included.

Any stubs that are determined to be damaged by the project inspector shall be removed and replaced to the right-of-way line.

1.21 STORM WATER POLLUTION PREVENTION PLAN

- A. The Storm Water Pollution Prevention Plan (SWPPP) for this project is governed by sections 01410, 01570, 01575 and the layouts provided in this project manual. Contractor shall comply with Storm Water Pollution Prevention Plan as shown in the construction drawings. These plans are prepared per the Traffic Control plans phases and steps. There is no separate pay item or cash allowance for Storm Water Pollution Prevention Plan implementation and maintenance /clean up; the cost is incidental to unit price of filter fabric fence and inlet protection barrier.

1.22 ALTERNATIVE CONSTRUCTION METHODS

- A. Alternate construction method will be allowed in accordance with applicable details and specifications in Contract Documents at no additional cost to the City of Houston provided City will receive substantial benefit from alternate construction method(s). Contractor accepts responsibility for all additional cost of geotechnical investigations and incidental items, including any re-design that may be necessary. Submit following for review by City Engineer prior to commencement of any construction activity if such alternate construction methods are to be considered. All modifications as listed below must be signed and sealed by a Licensed Professional Engineer registered in the State of Texas prior to submittal to City Engineer.
 1. Revisions to horizontal or vertical alignment.
 2. Revisions to access manhole details, if applicable.
 3. Revisions to line valve and operator manhole details, if applicable.
 4. Revisions to vacuum relief valve vault details, if applicable.
 5. Revisions to cathodic protection system, if applicable.
 6. Proposed construction method and detailed plan of approach.
 7. Location of access shafts, if applicable.
 8. Proposed traffic control plan.
 9. Revisions to material specifications.
 10. Impacts of revised alignment on hydraulic surge potential on line segment in question and all adjacent line segments, existing or proposed.

1.23 PIPELINES

- A. Refer to Section 02317 – Excavation and Backfill for Utilities for specific requirements on excavating near pipelines.

1.24 SOIL CONDITIONS & ENVIRONMENTAL SITE ASSESSMENTS (ESA)

- A. Based on the Environmental Site Assessment Phase I report and the Geotechnical Investigation Report No. 1130022702 prepared by Geotest Engineering, Inc. in May 2016, there are records of environmental contamination within the limits of this project. Therefore, removal and disposal of the contaminated soil or ground water is necessary.
 - 1. Geotechnical Report No. 196-90E prepared by Muillo Engineering, Incorporated, November 1990.
 - 2. Geotechnical Report No. G297-05 prepared by Aviles Engineering Corporation, February 2006.
 - 3. Geotechnical Report No. G294-00 prepared by Aviles Engineering Corporation, February 2001.
 - 4. Geotechnical Report No. 1140211301 prepared by Geotest Engineering, Inc., May 2016.
 - 5. ESA Phase I Report No. 1130022701 prepared by Geotest Engineering, Inc., May 2016.
 - 6. ESA Phase I Report No. 1130022702 prepared by Geotest Engineering, Inc., May 2016.
- B. Bidder(s) must entirely evaluate and take the soil conditions into account for successful implementation of the work as per the Geotechnical Report.
- C. The compact discs (CD) of the Geotechnical and ESA Reports are provided along with the bid document.

1.25 POTENTIALLY PETROLEUM CONTAMINATED AREAS

- A. Based on the Phase I Environmental Site Assessment Report (1130022702), prepared by Geotest Engineering, Inc. on May 24, 2016 states there are three (3) Recognized Environmental Conditions (RECs) sites and are potentially petroleum contaminated areas. These three sites are Minute Maid Area (inside the parking lot), Hillcroft and Bellaire and West Bellfort at US 59.

1.26 SAFETY SYSTEMS

- A. The drawings and any other drawings (including shop drawings, as built drawings or record drawings), addenda, change orders and specifications, prepared for this project do not extend to or include designs or systems pertaining to the safety of the construction contractor or its employees, agents, or representatives in their performance of the work. The seals of the registered/licensed professional engineers hereon do not extend to any such safety systems that may now or hereafter be incorporated in these drawings. The construction contractor shall prepare or obtain the appropriate safety systems, including the drawings and specifications required by House Bill 662 and 665 enacted by the Texas Legislature.

1.27 CENTERPOINT ENERGY ELECTRICAL FACILITIES

- A. Overhead lines may exist on property. We have not attempt to mark those lines since they are clearly visible. All lines should be located prior to construction, Texas Law, Section 752, Health and Service Code forbids all activities in which persons or things may come within six (6) feet of live overhead high voltage lines. Parties responsible for work, including contractors are legally responsible for safety of construction workers under this law. This law carries both criminal and civil liability. To arrange for lines to be turned off or removed, call CenterPoint Energy at 713-207-2222.
- B. Location of CenterPoint Energy electrical facilities are approximate and have not been verified by actual field check.
- C. Contractor shall hand dig within 18-inches of CenterPoint Energy underground electrical facilities.
- D. Overhead electric lines exist on and adjacent to the project site, which may be live during the construction period. Contractor shall facilitate his or her work so as not to interrupt services unless permitted by CenterPoint Energy.
- E. Contractor shall exercise caution when working in the vicinity of CenterPoint Energy electrical cable, underground wiring and overhead lines.
- F. When excavating within 5 feet and beneath a depth of 3 feet below existing grade of a utility pole or anchor to which CenterPoint Energy facilities are attached, CenterPoint Energy will secure or brace these poles and anchor prior to excavation unless the pole requires relocation due to construction. The cost of CenterPoint Energy's efforts is incidental. No separate pay item.

1.28 CENTERPOINT ENERGY UNDERGROUND FACILITIES

- A. Locations of CenterPoint Energy main lines (to include Unit Gas Transmission and/or Industrial Gas Supply Corporation where applicable) are shown in an approximate location only. Service lines are not usually shown. The contractor shall contact the Utility Coordinating Committee at 713-223-4567 or 1-800-669-8344 a minimum of 48 hours prior to construction to have main and service lines field located.
- B. When CenterPoint Energy pipeline markings are not visible, call 713-967-8037 (7:00 am to 4:30 pm) for status of line location request before excavation begins.
- C. When excavating within eighteen inches (18") of the indicated location of CenterPoint Energy facilities, all excavation must be accomplished using non-mechanized excavation procedures.
- D. When CenterPoint Energy facilities are exposed, sufficient support must be provided to the facilities to prevent excessive stress on the piping.
- E. The contractor is fully responsible for any damages caused by his failure to exactly locate and preserve these underground facilities.
- F. All gas facilities are the property of CenterPoint Energy, unless otherwise noted.

1.29 AT&T

- A. The locations of AT&T utilities are shown in an approximate way only. The contractor shall determine the exact location before commencing work. He agrees to be fully responsible for any damages and all damages, which might be occasioned by his failure to exactly locate and preserve these underground utilities.
- B. Call 1-800-344-8377 a minimum of 48 hours prior to construction to have underground lines field located.
- C. When excavation within eighteen inches (18”) of an indicated location of AT&T facilities, all excavations must be accomplished by using non-mechanized excavation procedures. When boring, the contractor shall expose AT&T facilities.
- D. When AT&T facilities are exposed, the contractor will provide support to prevent damage to the conduit ducts or cables. When excavating near telephone poles, the contractor shall brace the pole for support.

1.30 TREE PRESERVATION AND TREATMENT SPECIFICATIONS

- A. Contractor shall contact HPARD Urban Forestry Department at 832-395-8459 at least 1-2 weeks prior to tree trimming, pruning, removal, etc.
- B. Contractor is responsible for obtaining all tree removal permits prior to any tree removals that are not included in the Tree Preservation and Tree Protection Plans, which are components of the construction documents for this project. The tree removal permit provided to the contractor by the City of Houston prior to construction, will only be issued for the trees listed in the drawings.
- C. The tree preservation and treatment plan and related specifications are included in the construction drawings and this project manual.
- D. Contractor shall maintain trees during planting operations and for a period of 24 months after completion of planting/ construction (substantial completion).

PART 2 PRODUCTS

2.01 TYPE OF PIPE FOR CONSTRUCTION OF WATER LINE

- A. Only welded steel pipe is allowed to be used in this contract and as called-out on Drawings. Certain details pertaining to all types of pipe have been included when a specific difference exists. Include cost associated with changes in installation and construction, tie-ins, valves, vaults, and other appurtenances to accommodate alternate pipe in unit cost of water line construction.
- B. Only one type of pipe material may be used where material alternate are allowed. When adjoining proposed large diameter water line to existing large diameter water line of different pipe material and/or coating, provide a flanged connection insulating kit, and isolation test station, unless otherwise approved by Project Manager. Specifications and design criteria have been provided for these types of pipe. It is Contractor's responsibility

- to ensure that type of pipe selected and resulting methods and means complies with requirements and limitations set forth herein and on Drawings including traffic control.
- C. Unless specifically identified on Drawings, types of materials used are Contractor's option. Manufacturer and subcontractor selection are within Contractor's control and will not warrant time extensions due to failure to produce required deliverables within Contract Time. Extension of Contract Time due to non-delivery of Contractor's choice of pipe material, which affects Contractor's schedule, will not be allowed. Contractor to submit pipe material and other critical submittals in a timely manner to allow sufficient review time by Project Manager and to maintain construction schedule.
 - D. Provide bends and fittings as required to comply with invert elevations shown on profile view of Drawings. Call outs of bends and fittings are not identified on Drawings in profile view.
 - E. Clearly identify different pipe classes of the same pipe material using colored concrete or similar marking as approved by Project Manager.
 - F. Provide electrical isolation when adjoining to pipe with different material or coating. Coating on the welded restrained portions of the piping shall be identical to the coating on the adjoining pipe sections.
 - G. All steel pipes shall be welded restrained joints, unless otherwise shown differently in Drawings and Details. No separate payment for restrained or welded joints.

PART 3 EXECUTION – Not Used

01110 – Summary of Work

Appendix A

HARRIS COUNTY FLOOD CONTROL DISTRICT 48 HOUR PRE-CONSTRUCTION NOTIFICATION



48 hours prior to beginning work in a HCFCF right-of-way, complete and submit this form and attachments to: Harris County Flood Control District, Property Management Department, Development Coordination and Inspection Section (DCIS), 9900 Northwest Freeway, Houston, Texas, 77092

And email or fax this form to: DCIS@hcfcd.org, Fax Number: 713-684-4212. If any questions, call 713-684-4116.

GENERAL INFORMATION

Project Name _____ Date _____
 HCFCF Unit No. _____ Permit No. _____
 Brief Description _____ Key Map Page _____
 OUTFALL **CHANNEL** **DETENTION** **UTILITY** **OTHER**

Proposed Construction Start Date: _____

CONTACT INFORMATION

Applicant _____ **Phone No.** _____

Contractor _____ **Phone No.** _____

Superintendent:	Phone No.:	Cell No.:
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Consultant Firm _____ **Phone No.** _____

Construction Engineer:	Phone No.:	Cell No.:
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ATTACHMENTS REQUIRED (check box if attached)

- Construction Drawings Signed by HCFCF
- Approval (Notification) to Work within HCFCF Right-of-Way. Notification # _____
- Copy of Corps of Engineers Section 404 individual permit, if applicable. Permit # _____
- Copy of Right-of-Way for non-Flood Control Feature, if applicable.

Certification that all applicable permits have been obtained _____
 Applicant Signature

THIS FORM DOES NOT CONSTITUTE APPROVAL TO ENTER A HCFCF RIGHT-OF-WAY.

Official Use Only:

Assigned To _____ DEV- ID # _____

SECTION 01270S

MEASUREMENT AND PAYMENT

The following supplement modifies Section 01270 – Measurement and Payment. Where a portion of the Specification is modified or deleted by this Supplementary Specification, the unaltered portions of the Specification shall remain in effect.

Insert the following paragraph:

1.08 MEASUREMENT AND PAYMENT FOR PROJECT SPECIFIC ITEMS.

A. SIMS BAYOU

1. Bid Item 26 - "Electrical". Payment will be on a lump sum basis. Payment will include labor, equipment, and materials necessary for demolition and installation of the various electrical improvements required to provide electric service to equipment at this site as indicated on the Drawings and in the Specifications. Payment includes electrical components as required by the applicable technical specifications included in Division 16, and testing of electrical components as required at this site. The lump sum payment is in lieu of payment that may be indicated in the technical specification sections for individual work and equipment components.
2. Bid Item 27 - "Instrumentation & Control (SCADA)". Payment will be on a lump sum basis. Payment will include labor, equipment and materials necessary for demolition of existing instrumentation and control equipment and installation of the various instruments, control equipment and panel enclosures, equipment accessories, communications and control equipment and SCADA improvements (SCADA – Supervisory Control and Data Acquisition) at this site, as indicated on the Drawings and in the Specifications. Payment includes applicable instrumentation, control and communications equipment as required by the applicable technical specifications included in Division 13, and testing of equipment as required at this site. The lump sum payment is in lieu of payment that may be indicated in the technical specification sections for individual work and equipment components.

END OF SUPPLEMENT

Approved by:

Arthur Morris, P.E.
Managing Engineer
Water Engineering Section
Engineering and Construction Division

Date

Section 01454 S

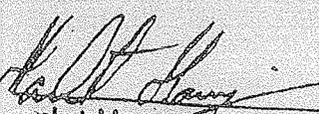
TESTING LABORATORY SERVICES

The following supplement modifies Specification Section 01454. Where a portion of the Specification is modified or deleted by this Supplementary Specification, the unaltered portions of the Specification shall remain in effect.

- 1. Add the following to paragraph 1.04:
 - "D. Unless otherwise notified by Project Manager, Project Manager shall schedule and monitor testing. Provide 24 hours notice of testing to avoid delay of work."

END OF SUPPLEMENT

Approved by:


 Aram Hovsepian, P.E.
 Chief Engineer

Engineering and Construction Division

Date 10/27/04

SECTION 01502S

MOBILIZATION

The following supplement modifies Specification Section 01502 - Mobilization Standard Specification. Where a portion of the Specification is modified or deleted by this Supplementary Specification, the unaltered portions of the Specification shall remain in effect.

1.02 MEASUREMENT AND PAYMENT. Delete paragraph 1.02 A and replace with the following paragraph 1.02 A:

- A. Mobilization will be paid on a project basis and separately per Work Order subject to following provisions:
 - 1. Project Mobilization: Measurement for mobilization is on a lump sum basis.
 - 2. Work Order Mobilization
 - a. A single Mobilization will be paid for each Work Order. A Work Order may include multiple activities in one location or related activities in multiple locations. Multiple Work Orders may be issued to complete a Work Order to account for changes in scope.
 - b. Failure to mobilize in required amount of time will result in liquidated damages per Document 00800 - Supplementary Conditions.

Replace the first sentence to paragraph C with the following:

- C. Project Mobilization payment will be included in monthly payment estimates upon written application by Contractor subject to following provision:

Add the following paragraphs D:

- D. Contractor will be required to mobilize equipment, materials and labor in a timely fashion for each Work Order.
 - 1. If directed by Project Manager, demobilize all equipment, materials, traffic control devices from site and protect all excavations and remobilize at a later date to continue work on the same Work Order (e.g., work hours may be limited to night only, which may require removal of equipment, materials, etc. in order to re-open all traffic lanes during the day).
 - 2. Demobilization/Remobilization – This Item is to be used in the event that the Project Manager requires the contractor to discontinue Work and return at a later date to complete Work. Some Unit Price Pay Items identified in Document 00410B may have to be repeated (i.e., Dewatering, Excavation). These repeated work items shall be paid under their respective Unit Price Items the appropriate number of times the work is performed. Contractor shall notify the Project Manager which items are anticipated to be repeated upon notice of demobilization and work conscientiously to minimize repeated work. Payment also includes effort to Remobilize following the demobilized period: All equipment and materials, including

traffic control, should be returned to the site and temporary restoration measures will be removed.

- a. Level 1 Demobilization/Remobilization: To be used prior to dewatering and valve rehabilitation. Payment will be made for each occurrence, and includes, but not limited to the following:
 - 1) Remove equipment, materials, waste products, temporary facilities, storage boxes, and other resources from site.
 - 2) Temporary backfill open excavations. Backfill shall comply with applicable specifications, including type of materials and compaction requirements.
 - 3) Reopen roads, driveways, sidewalks and other public facilities. Temporary restoration measures shall comply with applicable Federal, State and City regulatory requirements. Temporary restoration shall include but not limited to temporary asphalt, pavement striping, traffic control signage and street signage.
 - 4) Remove temporary traffic control from project site area.
 - 5) Coordination with and rescheduling of proposed work and subcontractors.
 - b. Level 2 Demobilization/Remobilization: To be used after dewatering and valve rehabilitation work has begun. Payment will be made for each occurrence, and includes, but not limited to the following:
 - 1) Level 1 Demobilization/Remobilization items
 - 2) Cleaning and removal of work-related debris from pipe interior
 - 3) Reinstallation of access manway flanges
 - 4) Remove Temporary Line Stop Valve, if applicable
 - 5) Contractor to work around the clock to complete any valve installation, if applicable
 - 6) Preparatory work to assist the City with flushing and disinfection to place line back in service.
3. Demobilization period shall not extend beyond original Work Order Contract Time without issuance of a supplemental Work Order.

END OF SUPPLEMENT

Approved by:

Arthur Morris, P.E.
Managing Engineer
Water Engineering Section
Engineering and Construction Division

Date

Section 01555S

TRAFFIC CONTROLS AND REGULATIONS

The following supplements modify Section 01555 – Traffic Control and Regulations Standard Specification. Where a portion of the Specification is modified or deleted by this Supplementary Specification, the unaltered portions of the Specification shall remain in effect.

1.01 MEASUREMENT AND PAYMENT: Delete paragraph 1.02 A.1 and replace with the following to paragraph:

1. Traffic control and regulation. Payment for traffic control and regulation is on a lump sum basis for each Work Order. A Work Order may include multiple activities in one location or related activities in multiple locations. Multiple Work Orders may be issued to complete a Work Order to account for changes in scope. Include preparation and submittal of traffic control plan if different than shown on Drawings, and provision of traffic control devices, equipment, and personnel necessary to protect the Work and public. Payment will be based on Contract's Schedule of Values for traffic control and regulation.

Replace paragraph 1.02 A.3 with the following:

3. Flagmen: Measurement is on a lump sum basis for flagmen as required for each Work Order. The amount invoiced shall be determined based on the schedule of value submitted for flagmen.

END OF SUPPLEMENT

Approved by:

Arthur Morris, P.E.
Managing Engineer
Water Engineering Section
Engineering and Construction Division

Date

Section 02105

CHEMICAL SAMPLING AND ANALYSIS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Preparatory work related to site remediation and excavation in a Potentially Petroleum Contaminated Area (PPCA).
- B. Sampling and analysis of site material.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices

- 1. Preparatory work is paid on a lump sum basis. Item includes hiring environmental consultants, preparing Environmental Health and Safety Plan, preparing Environmental Work Plan, training personnel, and obtaining permits and additional insurance.
- 2. Underground Utility Construction in PPCA:
 - a. Underground utility construction and appurtenances in areas identified within PPCA limits is on a linear foot basis, each basis, or lump sum basis, as shown in **Document 01270 - Schedule of Unit Price Work**.
 - b. Payment includes compensation for labor, equipment, and supervision for mobilization, environmental monitoring and field screening, handling, sampling, and testing of contaminated soil and ground water. Contaminated soil may be Category I or II. Contaminated groundwater will be that encountered during excavation for underground utilities and flowing at a rate not greater than 20 gallons per minute. Included in this pay item is incremental cost for upgraded piping, gaskets, and appurtenant materials.
 - c. Limits of measurement under this section are noted on Drawings as “Begin PPCA Excavation” and “End PPCA Excavation”, and other areas determined by Project Manager during the course of the work.

- d. Payment will be made upon receipt of field test reports from approved analytical laboratory.
 - 3. A force account for Extra Work for PPCA Handling will be used to compensate for time and materials required for additional work associated with PPCA when directed by Project Manager to perform such work and for which there is no bid item. Authorization and compensation for this work will be in accordance with Document 00700 - General Conditions.
 - 4. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 REFERENCE STANDARDS

- A. ASTM D 5092 - Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers.
- B. Code of Federal Regulation (CFR), Title 40, Section 261.24. - Protection of the Environment.
- C. CFR, Title 29, Section 1910.120. - Occupational Safety and Health Administration, Department of Labor.
- D. CFR, Title 29, Section 1926. - Occupational Safety and Health Administration, Department of Labor.
- E. CFR, Title 40, Section 261, Appendix II. - Protection of the Environment.
- F. Texas Administrative Code (TAC), Title 30, Chapter 335. - Industrial Solid Waste & Municipal Hazardous Waste.
- G. TAC, Title 30, Chapter 334. - Underground and Aboveground Storage Tanks.
- H. TAC, Title 30, Chapter 106.533. - Exemptions from Permitting, Subchapter X. Waste Processes and Remediation.
- I. U.S. Environmental Protection Agency (EPA), (SW-846) Test Methods for Evaluating Solid Waste, Office of Solid Waste and Emergency Response, Washington, D.C. (P1388-239223, November 1986).

- J. Texas Commission on Environmental Quality (TCEQ) Interoffice Memo, dated 4/12/94, by Chris Chandler, RPR Section, PST Division, regarding Revised Procedures for Classifying and Assigning Waste Codes for Underground and Aboveground Petroleum Storage Tank Wastes (text attached following this section).

1.04 DEFINITIONS

- A. Petroleum: Crude oil, natural gas, natural gas liquids, liquefied natural gas, and synthetic gas usable for fuel, as well as distillates of crude oil including gasoline, kerosene, diesel oil, motor oil, waste oil, jet fuels, and fuel oil.
- B. Potentially Petroleum Contaminated Area (PPCA): An area within station-to-station locations identified on Drawings where petroleum contamination has been detected in the soil or groundwater. PPCA also includes areas where contamination is suspected or encountered during utility installation outside areas identified on Drawings, and such contamination has been verified by Project Manager.
- C. Category I Soil: Soil containing visual or physical evidence of contamination, as described in paragraph 3.01, and that is not Category II Soil.
- D. Category II Soil: Soil that contains petroleum contamination in excess of levels identified in paragraph 3.04, and is consistent with a classification as Special Waste-PST as defined by TCEQ in their interoffice memo dated 4/12/94, or soil that contains visible free product or is impacted with non-petroleum compounds detected above Risk Reduction Standard Number 2 levels as defined in Texas Administrative Code, Title 30, Chapter 335.
- E. Potentially Contaminated Groundwater: Water recovered in a groundwater control system located in PPCA or groundwater that contains visual or physical evidence of contamination, as described in paragraph 3.01, and such contamination has been verified by Project Manager.

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit an Environmental Work Plan within 30 days after issuance of Notice to Proceed.
 - 1. The Environmental Work Plan shall be prepared by a Corrective Action Project Manager licensed in Texas, who has completed 40-hours of Health and Safety Training and the required annual refresher training,

- and in the employment of a registered Corrective Action Specialist firm.
2. The Environmental Work Plan shall include the following items. Compile and arrange in a format that can be reviewed by TCEQ.
 - a. Proposed sequence of construction through PPCA;
 - b. Procedures for screening soil in PPCA, identifying Category I or II Soil;
 - c. Procedures for handling material from PPCA;
 - d. Proposed location of stockpile areas;
 - e. Proposed reuse of Category I Soil as trench backfill below depths of 30 inches;
 - f. Proposed methods for disposal or recycling of Category I or II Soil;
 - g. Proposed carriers of Category I or II Soil or potentially contaminated groundwater with verification each is properly licensed;
 - h. Proposed recycle/disposal sites for Category I or II Soil or potentially contaminated groundwater with verification that each is properly licensed;
 - i. Copy of permit required for discharge of potentially contaminated groundwater in sanitary sewer system, if to be disposed in sanitary sewer;
 - j. Name and qualifications of Corrective Action Project Manager and professional environmental consultants for health, environmental, and safety issues regarding operations within PPCA; and,
 - k. Proposed analytical laboratory with verification it is accredited by A2LA or other recognized association, or it is a participant in the EPAs Performance Evaluation Program.
 3. Do not commence work in PPCA until Environmental Work Plan has been reviewed and accepted by Project Manager.

- C. Submit Environmental Health and Safety Plan within 30 days after issuance of Notice to Proceed.
 - 1. The Health and Safety Plan shall be prepared by a Corrective Action Project Manager licensed in Texas, who has completed 40 hours of health and safety training, and required annual refresher training, or a Certified Industrial Hygienist.
 - 2. Include methods and procedures for assuring work, which will be conducted under conditions expected in the field, is safe.
- D. As work proceeds, submit field screening, monitoring and analytical laboratory test results on a weekly basis for soil and on a daily basis for groundwater. Summarize test results in tables together with applicable regulatory criteria.
- E. Submit copies of correspondence, reports, permits and other documents provided to, or received from, regulatory agencies.

1.06 PERSONNEL REQUIREMENTS

- A. Provide trained personnel who have completed minimum health and safety programs specified by the Occupational Safety and Health Administration in 29 CFR 1910.120. Before beginning work at the site, each employee that will work in PPCA is required to have completed 40 hours health and safety training and the required annual refresher training.

PART 2 P R O D U C T S

2.01 MATERIALS

- A. Do not use polyvinyl chloride or other plastic material, unless approved by Project Manager.
- B. Water Line Pipe Material.
 - 1. Furnish ductile-iron pipe or steel pipe material within station-to-station locations identified as PPCA on Drawings.
 - 2. Provide restrained joints for ductile-iron pipe or welded joints for steel pipe.
 - 3. Provide pipe material conforming to Section 02501 - Ductile-Iron Pipe and Fittings or Section 02502 - Steel Pipe and Fittings.

- C. Sanitary Sewer Pipe Material.
 - 1. Furnish ductile-iron pipe, centrifugally cast fiberglass pipe, or equivalent protective materials approved by Project Manager.
 - 2. Provide restrained joints.
 - 3. Provide pipe material conforming to Section 02501 - Ductile-Iron Pipe and Fittings or Section 02504 - Centrifugally Cast Fiberglass Pipe. Use pipe with a minimum pressure rating of 150 psi.

- D. Use Viton (FKM) type gaskets, or other material as recommended by the pipe manufacturer, for water lines, sanitary and storm sewer pipe, and appurtenances requiring gaskets.

PART 3 EXECUTION

3.01 POTENTIALLY PETROLEUM CONTAMINATED AREAS

- A. Conduct operations in PPCA in accordance with the accepted Environmental Work Plan and the Environmental Health and Safety Plan and to minimize the spread of contamination. In other areas which are either detected or suspected to be potentially petroleum contaminated areas, immediately notify Project Manager and proceed with work in accordance with this Section, unless otherwise directed by Project Manager.

- B. Immediately notify Project Manager and TCEQ's Region 12 Field Office whenever Category I or II Soil or potentially contaminated groundwater are encountered.
 - 1. Provide location, depth, type (soil or groundwater), source (if known), and evidence of suspected contamination.

 - 2. Determine if Category I Soil or potentially contaminated groundwater is present by visual or physical evidence of contamination. Visual or physical evidence includes:
 - a. Petroleum or chemical odor.
 - b. Indication of levels of contamination by air monitoring devices employed as part of the Environmental Health and Safety Plan.
 - c. Soil or groundwater discoloration.
 - d. Material oozing/dripping into excavation.

- e. Liquid or oily sheen floating on groundwater.
 - f. Buried containers or refuse.
 - g. Field screening □head-space□ results in excess of a 25 ppm reading on a photoionization detector (PID) or flame ionization detector (FID).
- C. Install piping and gasket materials and appurtenances in conformance with appropriate section, except as modified in this Section.
- D. Construct trench dams within a utility trench at each boundary of PPCA and laterals to minimize potential for contaminant transport within pipe bedding material. A trench dam shall consist of at least 24 inches of cement stabilized sand with 10 percent bentonite clay added, extending from 6 inches below bottom of trench to within 12 inches of limits of topsoil or pavement.

3.02 ENVIRONMENTAL MONITORING

- A. An environmental consultant shall monitor conditions in PPCA, as specified in the Environmental Health and Safety Plan. Maintain safe working conditions in accordance with OSHA requirements (29 CFR 1926).3.03 SCREENING PPCA SOILS

- A. An environmental consultant shall perform field screening of soil removed from excavation or tunneling in PPCA.

B. Screening Procedures.

1. Place samples in a sealed plastic bag and place in a warm location for 15 minutes prior to screening.
2. Properly calibrate the PID/FID using a calibration gas. For PID use 100 ppm isobutylene and for FID use 100 ppm methane.
3. Open bag just enough to insert instrument probe and take maximum headspace reading.
4. Screen at least twice per hour while removing soils in open cut areas or shafts.
5. During tunneling, screen once for each pipe length in pipe jacked tunnels or each advance of tunnel shield in primary-lined tunnels. Screen at least once per shift when excavating.

3.04 SAMPLING AND TESTING

- A. Frequency.
 - 1. Sample soil in PPCA at a rate of not less than one composite sample for every 20 cubic yards of excavation or volume corresponding to every 50 linear feet of installed underground utility, whichever is more frequent.
 - 2. Sample water from PPCA to be discharged to a sanitary sewer one week prior to initiation of discharge, and at a rate of one grab sample once per day during discharge to sanitary sewer.
- B. Analyze soil samples for parameters listed in Table 01160-1, Soil Criteria - Petroleum Only, and in accordance with SW-846. Handle as a Category II Soil if analytical results indicate any one, or more, parameters exceed allowable Maximum Concentration listed in Table 01160-1. If benzene concentration from composite sample is greater than 5 milligrams per kilogram (mg/kg) or lead concentration is greater than 30 mg/kg, perform Toxicity Characteristic Leaching Procedure (TCLP) analysis of appropriate compound for that sample to determine if a more stringent disposal classification is warranted. If contaminants other than petroleum are suspected, immediately notify Project Manager who will determine the list of parameters to be analyzed. If such are encountered, compensation will be made under the Allowance for PPCA Handling. Use a 4-part representative composite sample for analysis of parameters, except when inconsistent with SW-846.
- C. Analyze groundwater samples for discharge to sanitary sewers. Analyze samples for BTEX by EPA Method 602, 8020, or 8021; TPH by EPA Method 418.1 or Method TX 1005; and LEL in accordance with EPA Method 1010.
- D. Conduct analyses by proposed analytical testing laboratory listed in Environmental Work Plan.

3.05 AIR MONITORING REQUIREMENTS

- A. Ensure health and safety of workers at the construction site. Maintain air quality within the construction zone to conform to exposure limits specified in Code of Federal Regulations (CFR) Title 29, Section 1910.120 enforceable by OSHA.
- B. Provide adequate shoring and sufficient escape ladders in accordance with applicable trench safety regulatory requirements.

- C. In the trench, continuously operate a combustible gas indicator (CGI) with LEL/O₂ meter to monitor vapor and oxygen levels. Properly calibrate CGI and provide an alarm that sounds if greater than or equal to 20 percent Lower Explosive Limit (LEL), less than or equal to 19.5 percent oxygen, or greater than or equal to 25 percent oxygen is reached. Record monitoring data from CGI every 15 minutes to ensure safe work conditions.
- D. Take appropriate measures during construction to keep LEL levels below 20 percent in the trench. If vapor concentrations exceed 20 percent of LEL stop construction work, turn off equipment, and have workers immediately vacate the PPCA in an upwind direction.
- E. Take readings with PID/FID 50 feet downwind of area during excavation or work in contaminated excavation areas and until one hour after cessation of such work. Take readings within breathing zone at approximately 4 feet above ground level. Record readings, date, time, initials of person taking reading, PID/FID serial number and last calibration date of PID/FID in bound field book.

END OF SECTION

Section 02120

OFF-SITE TRANSPORTATION AND DISPOSAL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Off-site disposal of non-hazardous and hazardous solid, liquid and resinous waste.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices

1. Payment for transportation and disposal of Class I and II Soils at approved facility is on a cubic yard basis.
2. No separate payment will be made for soil reused as backfill material.
3. Payment for transportation and disposal of contaminated groundwater at approved facility is on a per gallon basis.
4. No separate payment for ground water discharged into a sanitary sewer.
5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 REFERENCES

- A. CFR, Title 29, Section 1910.120.- Occupational Safety and Health Administration, Department of Labor.
- B. Texas Administrative Code (TAC), Title 30, Chapter 335.- Industrial Solid Waste & Municipal Hazardous Waste.
- C. TAC, Title 30, Chapter 334.- Underground and Aboveground Storage Tanks.

- D. TAC, Title 30, Chapter 106.533.- Exemptions from Permitting, Subchapter X, Waste Processes and Remediation.
- E. U.S. Environmental Protection Agency (EPA), (SW-846) Test Methods for Evaluating Solid Waste, Office of Solid Waste and Emergency Response, Washington, D.C. (P1388-239223, November 1986).

PART 2 P R O D U C T S (Not Used)

PART 3 E X E C U T I O N

3.01 H A N D L I N G C A T E G O R Y I A N D I I S O I L S

- A. Do not place Category II Soil back into excavation. Properly dispose of Category II Soil at the facility listed in Environmental Work Plan. Category I Soil consistent with classification as Class II PST Waste as defined by Texas Commission on Environmental Quality (TCEQ) in their interoffice memo dated 4/12/94, and not Category II Soil (as demonstrated through laboratory testing) can be reused as backfill material, provided;
 - 1. Soil is reused in the same area from which it originated at depths greater than 30 inches below top of pavement, finished grade or ditch flowline, whichever is lower.
 - 2. Soil has suitable engineering properties for backfill material as specified in Section 02320 - Utility Backfill Material.
 - 3. Does not have indications of impact by contaminants other than petroleum.
- B. Do not spread Category I or II Soil on ground surface.
- C. Place Category I or II Soil in covered roll-off box with a minimum 20-mil plastic liner or in a stockpile at temporary storage area, pending receipt of analytical results and receipt of authorization from TCEQ and the disposal site for final disposal; or, in trucks for transport directly to the disposal facility.
 - 1. Do not commingle Category I or II Soil from different locations or with different sources.
 - 2. Temporary storage area to meet following criteria:
 - a. Within 2 miles of project site, to allow access by City personnel, unless otherwise approved by Project Manager.
 - b. Outside the 100-year floodplain.

- c. Outside of, and not adjacent to, an area known or suspected to be a wetland.
 - d. Acceptable to Project Manager.
 3. Secure using temporary fencing or other means of controlling access.
 4. Place stockpiled soils on an impervious membrane. Surround with a berm to prevent migration of soils or moisture either into or out of the stockpile, other than evaporation.
 5. Protect and cover the stockpile with minimum 20-mil plastic or other approved waterproof membrane covering. Replace damaged covers.
 6. Do not place soil over monitoring wells or piezometers, utility line manholes, or any other potential route for water to migrate to subsurface.
 7. Handle runoff from the temporary storage area in accordance with paragraph 3.06, Handling Water.
 8. Do not stockpile soil for greater than 30 days.
 9. Remove remaining material, including excavated soil from construction site, from temporary storage area prior to completion of Work.
- D. Remove, handle, transport, stockpile, and dispose of Category II Soil under direction of Corrective Action Project Manager. Dispose waste classified (i.e., meets characteristics or other definitions of) a hazardous waste consistent with Resource Conservation and Recovery Act (RCRA) and 30 TAC Chapter 335.
- E. Transport Category I or II Soil in accordance with Department of Transportation (DOT) and TCEQ rules and regulations.
- F. Dispose Category I Soil, not reused as backfill, under direction of Corrective Action Project Manager, at a properly licensed facility with prior approval of Project Manager.
- G. Obtain signed manifests from the receiving facility and provide originals to Project Manager.
- H. Decontaminate large equipment to prevent cross-contamination with clean material. Steam clean or pressure wash dump trucks, bulldozers, backhoes,

and other large equipment prior to use in uncontaminated areas after being used in PPCA.

3.02 HANDLING WATER

- A. Prior to discharging petroleum contaminated groundwater, obtain an Industrial Wastewater Discharge Permit (no cost) from the City for disposal directly to a sanitary sewer which discharges to a City-owned wastewater treatment plant.
- B. Procedures.
1. Provide equipment sized to handle flows anticipated by dewatering operations.
 2. Include commercially available oil/water separator unit as part of the treatment system for dewatering operation discharging to sanitary sewer.
 3. Do not exceed limits listed in Table 01160-2, Potentially Contaminated Groundwater Discharge Limits for groundwater discharged to the sanitary sewer. Provide additional treatment systems as needed prior to discharge to sanitary sewers where groundwater contamination levels exceed those noted in Table 01160-2. Approval by Project Manager shall be obtained for proposed treatment system prior to initiation of treatment and discharge.
 4. Comply with all applicable requirements of 30 TAC, Chapter 106.533, including submitting a PI-7 form to the TCEQ for a standard exemption of oil/water separator unit, and any additional treatment systems. Submit copy of PI-7 form to Project Manager.
 5. Do not discharge treated water into sanitary sewer if water level is within one foot of the top of sanitary sewer manhole or would cause an overflow situation.
 6. Recover free product collected in treatment equipment. Recycle for beneficial reuse or dispose of recovered contaminants in a manner acceptable to Project Manager and TCEQ.
 7. Transport potentially contaminated groundwater and free product in accordance with DOT and TCEQ rules and regulations for flammable products. Use DOT-licensed carrier for transport.
 8. Obtain signed manifests for potentially contaminated groundwater and free product from the receiving facility and provide originals to Project Manager.

9. Furnish laboratory reports to Project Manager within one week of sample date.

- C. Install and operate groundwater control systems, as described in Section 01578 - Control of Groundwater and Surface Water. Design and operate groundwater control systems so water from PPCA is handled in a system separated and isolated from groundwater control systems outside PPCA.
- D. Handle, test, treat, and discharge potentially contaminated groundwater to the sanitary sewer in accordance with City of Houston, Industrial Wastewater Discharge Permit requirements, or have water evacuated and hauled for off-site treatment and disposal at a TCEQ-permitted facility. Perform discharge under direction of Corrective Action Project Manager.

3.03 AIR MONITORING REQUIREMENTS

- A. Ensure health and safety of workers at the construction site. Maintain air quality within the construction zone to conform to exposure limits specified in Code of Federal Regulations (CFR) Title 29, Section 1910.120 enforceable by OSHA.
- B. Provide adequate shoring and sufficient escape ladders in accordance with applicable trench safety regulatory requirements.
- C. In the trench, continuously operate a combustible gas indicator (CGI) with LEL/O₂ meter to monitor vapor and oxygen levels. Properly calibrate CGI and provide an alarm that sounds if greater than or equal to 20 percent Lower Explosive Limit (LEL), less than or equal to 19.5 percent oxygen, or greater than or equal to 25 percent oxygen is reached. Record monitoring data from CGI every 15 minutes to ensure safe work conditions.
- D. Take appropriate measures during construction to keep LEL levels below 20 percent in the trench. If vapor concentrations exceed 20 percent of LEL stop construction work, turn off equipment, and have workers immediately vacate the PPCA in an upwind direction.
- E. Take readings with PID/FID 50 feet downwind of area during excavation or work in contaminated excavation areas and until one hour after cessation of such work. Take readings within breathing zone at approximately 4 feet above ground level. Record readings, date, time, initials of person taking reading, PID/FID serial number and last calibration date of PID/FID in bound field book.

3.04 DISPOSAL OF MATERIAL

- A. Non-categorized Material. Dispose of excess or unsuitable excavated materials, not Category I or II Soil, off-site in accordance with Section 01576 - Waste Material Disposal.
- B. Category I or II Soil. Dispose of excess or unsuitable excavated materials off-site at a state registered Treatment, Storage, or Disposal (TSD) facility. Obtain signed manifests from the receiving facility and provide originals to Project Manager.

**TABLE 01160-1
SOIL CRITERIA - PETROLEUM ONLY**

Contaminant	Maximum^a Concentration (mg/kg)	Method
TPH	1500	EPA 418.1/TX 1005
Total BTEX ^b	150	EPA 8020/8021
Total Lead ^c	250	EPA 6000/6010/7000

- Notes: ^a If any parameters exceed the maximum concentrations, then the soil shall be considered Category II Soil and a Special Waste-PST as defined by the TCEQ in their interoffice memo dated 4/12/94.
- ^b If benzene is greater than 5.0 mg/kg then analyze TCLP benzene which should be <0.3 mg/l.
- ^c If total lead is greater than 30 mg/kg then analyze TCLP lead which should be <1.5 mg/l.

Definitions: TCLP - toxicity characteristic leachate procedure (40 CFR 261, Appendix II)
BTEX - benzene, toluene, ethyl benzene, and total xylenes
TPH - total petroleum hydrocarbons
mg/kg - milligrams per kilogram
mg/l - milligrams per liter

TABLE 01160-2
POTENTIALLY CONTAMINATED GROUNDWATER DISCHARGE LIMITS

Parameter	Discharge to Sanitary Sewer	
	Limit	Method
TPH (mg/l)	30.0	EPA 418.1/TX 1005
Total BTEX (mg/l)	1.0	EPA 602/8020/8021
Lower Explosive Limit (%)	10	EPA 1010

Notes: See definitions above.

END OF SECTION

Section 02221S

REMOVING EXISTING PAVEMENTS AND STRUCTURES

The following supplement modifies Specification Section 02221 –Removing Existing Pavements and Structures. Where a portion of the Specification is modified or deleted by this Supplementary Specification, the unaltered portions of the Specification shall remain in effect.

1.02 MEASUREMENT AND PAYMENT

Delete the last sentence in paragraph 1.02 A.2. Insert the following paragraph and renumber the remaining:

3. Payment for removing and disposing concrete curb or curb and gutter is on a linear foot basis. Payment also includes any saw-cuts needed for removal.

END OF SUPPLEMENT

Approved by:

Arthur Morris, P.E.
Managing Engineer
Water Engineering Section
Engineering and Construction Division

Date

Section 02317S

EXCAVATION AND BACKFILL FOR UTILITIES

The following supplements modify Section 02317 – Excavation and Backfill for Utilities Standard Specification. Where a portion of the Specification is modified or deleted by this Supplementary Specification, the unaltered portions of the Specification shall remain in effect.

1.02 MEASUREMENT AND PAYMENT:

Delete paragraph 1.02 A.1 and replace with the following paragraph:

1. Unit Price Work Items are included for each Exploratory Excavation. Pay Item will be used in order to expose the exterior of existing pipe or appurtenances in order to perform rehabilitation. Payment will be considered full compensation for excavation, shoring, and maintenance of open excavation, including removal of ground water, surface water, and leaking potable water (up to one 6-inch pump for two days) for Contractor to complete rehabilitation, and final backfill.
 - a. Full length of pipe (20 feet) is to be exposed with an additional 2 feet past the joint on both sides (24 feet total of exposed pipe).
2. Extra Unit Price Work Items are included for the placement and removal of granular backfill (3/4-inch crushed limestone or other approved material) to be used for bottom of excavation during welding. Payment is per cubic yard of backfill used.

END OF SUPPLEMENT

Approved by:

Arthur Morris, P.E.
Managing Engineer
Water Engineering Section
Engineering and Construction Division

Date

SECTION 02371(Large Diameter)

EROSION CONTROL AND VEGETATION MAT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Installation of erosion control and vegetation mat for disturbed areas that are seeded.

1.02 PAYMENT

- A. No separate payment will be made for erosion control and vegetation mat. Include cost in unit price for regrading existing ditches.

1.03 DESCRIPTION

- A. Mat shall cover newly seeded and fertilized ground, and shall be held in place with netting and staples driven into ground.
- B. Mat shall assist in germination of grass seedlings and protect seedlings and establish vegetation.
- C. Mat shall be specifically designed for use on steep slopes and other hard-to-hold problem areas.
- D. Mat shall help ground retain moisture, control surface temperature fluctuations of soil, conform to terrain, protect seedlings against sun burnout, and break up raindrops to prevent erosion.
- E. Wood fibers of blanket ultimately shall attach to soil, stabilize terrain, and act as mulch after vegetation has started.
- F. Netting shall degrade in time in sunlight.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Erosion Blanket:
 - 1. Machine produced mat consisting of 100 percent wood with 80 percent 6-inch or longer fiber length, with

- consistent thickness and fiber evenly distributed over entire area of blanket.
2. Topside of blanket shall be covered with 3/4-inch by 3/4-inch mesh of biodegradable netting.
 3. Blanket shall be made smolder-resistant with use of chemical additives.
- B. Staples:
1. 11-gauge biodegradable steel.
 2. "U" shaped with legs 6 inches in length and 1-inch crown.

2.02 ACCEPTABLE PRODUCT

- A. Standard Excelsior Erosion Control Blanket; Erosion Control Systems, Inc.

PART 3 E X E C U T I O N

3.01 PREPARATION

- A. Properly cultivate, seed and fertilize area to be covered in compliance with Section 02921 - Hydromulch Seeding.
- B. Apply blanket immediately over prepared ground.

3.02 APPLICATION

- A. Unroll blanket over prepared area; keep netting on top and fibers in contact with soil over entire area.
- B. Apply blankets in ditches in direction of water flow.
- C. Butt edges snugly (overlap maximum 2 inches) and fasten to ground with staples driven into ground.
- D. Engage portion of netting with staple and set flush with soil surface.
- E. Use average of 1 to 1-1/2 staples per yard and maximum of 1-1/2 feet distance between staples at ends. Follow stapling procedure as recommended by manufacturer.
- F. Individual blanket size: 7.5 feet by 96 feet (80 square yards) with weight of 68 pounds plus or minus 1 pound.

END OF SECTION

Section 02425(Large Diameter)

TUNNEL EXCAVATION AND PRIMARY LINER FOR WATER MAINS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tunnel construction operation with primary lined tunnel installed during tunnel drive followed by placement of water line inside tunnel after completion of tunnel construction. This Specification is intended to be primarily functional in nature and to define in general terms work to be accomplished. Contractor granted full discretion to select method of tunnel construction, subject to review by City Engineer.

1.02 MEASUREMENT AND PAYMENT

- A. No separate payment will be made for other work performed under this Specification such as excavation, liner, grouting, or instrumentation. Include cost of such other work in contract unit prices for items listed in bid form for Section 02517 - Water Main in Tunnels.
- B. Where such effort is necessary, cost for ground water control during course of tunnel work included in unit prices for water main in tunnel.
- C. Ground water control required during course of Project to lower water table for other utility installation, to remove standing water, surface drainage seepage, or to protect ongoing work against rising waters or floods considered incidental to work being performed.

1.03 REFERENCE STANDARDS

- A. The publications listed below form part of this specification to extent referenced. publications are referred to in text by abbreviations only.
 - 1. AREMA Manual for Railway Engineering (Applicable sections).
 - 2. American Association of State Highway and Transportation Officials (AASHTO).
 - 3. American Society for Testing and Materials (ASTM).
 - a. ASTM A36 - Standard Specifications for Carbon Structural Steel.
 - b. ASTM A82 - Standard Specifications for Steel Wire, Plain, for Concrete Reinforcement.
 - c. ASTM A185 - Standard Specifications for Steel Welded Wire Fabric for Concrete Reinforcement.

- d. ASTM A283 - Standard Specifications for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - e. ASTM A307 - Standard Specifications for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - f. ASTM A328 - Standard Specifications for Steel Sheet Piling.
 - g. ASTM A496 - Standard Specifications for Steel Wire, Deformed, for Concrete Reinforcement.
 - h. ASTM A615 - Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - i. ASTM C33 - Standard Specification for Concrete Aggregates.
 - j. ASTM C150 - Standard Specifications for Portland Cement.
4. American Water Works Association (AWWA)
- a. AWWA C200 - Steel Water Pipe 6-inches and Larger.
5. Occupational Safety and Health Administration (OSHA): Particular attention is called to Subpart S of OSHA Standards (29 CFR 1926/1920), published as U.S. Department of Labor Publication 2207, Revised Oct. 1, 1979. Second revision dated August 1, 1989. See Federal Register dated June 2, 1989 for revised standard and commentary.

1.04 DEFINITION

- A. Tunneling Work Plan defined as written description together with sketches, drawings, schedules, and other documents defining Contractor's planned methods and procedures to construct referenced item. Contractor's Construction Drawings defined as drawings by which Contractor proposes to furnish, construct, install, and operate referenced item. Submission of Tunneling Work Plans, including construction drawings, required for providing City Engineer sufficient details to verify that Contractor's planned work and work in progress is in accordance with intent of design and specification requirements.
- B. Primary Liner defined as Contractor's initial construction liner and tunnel support installed by Contractor for ground stability and safety during construction preparatory to installation of water line. Contractor chooses method of construction in accordance with this Specification. Inclusion of various methods in specification or reviews by City Engineer of Contractor's submittals shall not be construed by Contractor as endorsement by City Engineer that all such methods are constructible or will work for specific subsurface soils encountered.

- C. Carrier Pipe is referred to as water line or permanent (secondary) liner. Such water line/permanent liner defined and installed in accordance with Section 02517 - Water Main in Tunnels or Section 02511 - Water Mains.

1.05 SUBMITTALS

- A. Review: Conform to requirements of Section 01330 - Submittals Procedures. City Engineer will review submitted plans, details and data for compliance with requirements of Specification. Such review shall not be construed to relieve Contractor of responsibilities under Contract. Contractor shall not commence work on items requiring Contractor's work plan, construction drawings or other submittals until submittals have been reviewed and accepted by City Engineer. All structural designs and other engineered components signed and sealed by Professional Engineer registered in the State of Texas.

- B. Tunneling: Submit for review Tunneling Work Plan with complete construction drawings, complete written description identifying details of proposed method of construction and sequence of operations to be performed during construction, as required by method of tunnel excavation and liner installation. Sufficiently detail construction drawings and descriptions detailed to demonstrate to City Engineer whether proposed materials and procedures will meet requirements of Specification.

1. Depending on Contractor's method of construction, submit Contractor's work plan and construction drawings on following items:
 - a. If use of mechanized excavating equipment (such as TBM or shielded excavators) is proposed, submit arrangement drawings and technical specifications of machine and trailing equipment (included modifications), experience record with this type of machine of both Contractor and proposed operator and copy of manufacturer's operation manual for machine.
 - b. The Contractor may elect to use tunnel shield that is separate from mechanized excavation equipment or for use with hand excavation. When use of tunnel shield is proposed, submit arrangement drawings, design criteria, dimensional data and method of excavation and operation of shield, including acceptable method for supporting, controlling and closing face of heading.
 - c. Complete details of equipment, methods and procedures to be used for ground support, including but not limited to primary liner installation, timing of installation in relation to excavation plan, bulkheads and equipment.
 - d. Grouting techniques meeting requirements this Section and Section 02431 - Tunneling Grout.
 - e. Procedures for measuring excavation quantities versus forward progress during tunneling operation (for earth pressure balance TBM only).

- f. Method of controlling line and grade of excavation.
 - g. Details of muck removal, including equipment type, number and disposal location.
 - h. Description of ventilation system, lighting system, and electrical system.
 - i. Proposed contingency plans for critical phases and areas of tunneling.
2. Submit for review design criteria established by Contractor's Engineer for primary liner, including design calculations and installation details, and certification by qualified Engineer Registered in the State of Texas that structural design of primary tunnel meets criteria and specified requirements for range of field conditions.
 3. Include in work plan special activities at critical utility crossings, or for work potentially effecting other facilities and existing installations, where special precautions must be taken during construction.
 4. Submit for review layout and design of proposed access shafts and shafts for permanent installations in accordance with Section 02400 - Tunnel Shafts.
 5. Ground water control system per requirements in this Section and in accordance with Section 01578 - Control of Ground Water and Surface Water, as required by construction method.
 6. All structural designs and other engineered items signed and sealed by qualified Professional Engineer Registered in the State of Texas unless otherwise specified.
- C. Quality Control Methods: At least 30 days prior to start of tunneling, submit description of quality control methods he proposes to use in this operation to City Engineer. Include in submittal:
1. Supervision: Supervisory control to ensure that work is performed in accordance with Drawings and Specifications and Contractor's work plan and construction drawings.
 2. Line and Grade: Procedures for surveying, controlling and checking line and grade, including field forms for establishing and checking line, and grade.
 3. Tunneling Observation and Monitoring: Procedures for preparing and submitting daily logs of tunneling operations, including field forms, to meet requirement of Paragraphs 3.06, Tunneling Data and Paragraph 3.07, Control of Tunnel Line and Grade.
 4. Monitoring Instrumentation: Conform to requirements of Paragraph 3.09A, Monitoring Instrumentation.

- a. Name of instrument installation subcontractors.
 - b. Layout of instrumentation points.
 - c. Procedures, forms and schedules for periodic submittals of readings.
5. Settlement Survey Plan, to meet requirements of Paragraph 3.09C, Settlement Surveying. This plan may be submitted as part of Instrumentation Monitoring Plan.
6. Building Condition/Assessment Plans: Conform to requirements of Paragraph 3.09B, Buildings and Structures Assessment.
- D. Geotechnical and Environmental Investigation: Include results of geotechnical and environmental investigations performed by Contractor as relevant to tunneling in Work Plan.
- E. Safety: Submit procedures to meet all applicable OSHA requirements including the following as minimum: Submit these procedures for record purpose only and they will not be subject to approval by City Engineer.
1. Protection against soil instability and ground water inflow.
 2. Safety for shaft access and exit including ladders, stairs, walkways, and hoists.
 3. Protection against mechanical and hydraulic equipment operations, and for lifting and hoisting equipment and material.
 4. Ventilation, lighting, and communication systems.
 5. Monitoring for hazardous gases.
 6. Protection against flooding.
 7. Means for emergency evacuation.
 8. Protection of shaft including traffic barriers, accidental or unauthorized entry, and falling objects.
 9. Emergency protection equipment and self-rescue equipment.
 10. Safety supervising responsibilities.

1.06 DESIGN CRITERIA

- A. Design primary liner for appropriate loading conditions, including but not limited to: overburden and lateral earth pressures, handling and installation stresses, loads imposed by tunnel shield or tunnel boring machine thrust jacks, subsurface soil and water loads, grouting,

and all other conditions of service. Contractor responsible for design of primary liner to carry thrust of jacking or other construction forces or loads anticipated.

- B. Use Cooper E-80 locomotive loading distributions in accordance with AREA specifications for culverts for criteria at railroad crossings. Account for additive loadings for multiple tracks in design. Provide liner type for railroad crossings as specified or as otherwise required by railroad authority. Acceptable monitoring devices, such as closed circuit television, which permit continuous monitoring of conditions at face by qualified observers, from outside tunnel, may be used.
- C. Use HS-20 vehicle loading distributions for truck loading criteria in accordance with AASHTO.
- D. Compatibility of Methods:
 - 1. Use compatible methods of excavation, liner, and ground stabilization and ground water control.
 - 2. Design primary lining, when used to provide thrust for propulsion of shield, to withstand this thrust without damage or distortion. Configure propulsion jacks on shield so that thrust is uniformly distributed and will not damage or distort primary liner.
 - 3. Use compatible tunneling method with possible restrictions on work, such as influence on existing installations or potential ground water contamination.

1.07 JOB CONDITIONS

- A. Safety Requirements:
 - 1. Perform work in manner to maximize safety and avoid exposure of men and equipment to hazardous and potentially hazardous conditions, in accordance with applicable safety standards and Contractor's safety procedures.
 - 2. Whenever there is emergency or stoppage of work which is likely to endanger tunnel excavation or adjacent structures, operate full work force for 24 hours day, including weekends and holidays, without intermission until potentially hazardous conditions no longer exist or jeopardize stability and safety of work or existing installations.
 - 3. Perform tunnel construction in manner that will minimize movement of ground in front and surrounding tunnel. Prevent significant subsidence of surface and protect structures and utilities above, and in vicinity of, tunnel from damage.
 - 4. Support ground continuously in manner to prevent loss of ground and keep perimeters and faces of tunnel and bottoms of shafts stable. Use filter-fabric and other means as necessary behind primary liner to prevent soil migration into tunnel.

- B. Surveillance of Headings: When Contractor is not able to close face of machine because of maintenance requirements, maintain qualified personnel on duty to observe conditions that might threaten stability of heading whenever tunnel excavation is suspended or shut down. Equip personnel with approved contingency plan to take appropriate action to prevent or limit damage should conditions which threaten stability of heading occur.
- C. Air Quality:
1. Conduct tunneling operations by methods and with equipment which will positively control dust, fumes, vapors, gases or other atmospheric impurities in accordance with OSHA, Federal, State and City requirements.
 2. Provide approved mining instrumentation for testing quality of tunnel atmosphere and obtain samples, under working conditions, at prescribed intervals in accordance with above referenced requirements. Submit results of air quality tests to City Engineer.
- D. Ground Conditions: Perform sufficient exploration by geotechnical and environmental borings in advance of construction to define necessary parameters for design of primary tunnel liner, planning and designing ground water control system, and for selection of tunneling method and equipment to successfully complete each tunnel reach. Present results of Contractor's geotechnical and environmental investigations in related work plans.

PART 2 PRODUCTS

2.01 GENERAL

- A. Use of various construction methods for tunnel excavation and ground support, such as by tunnel boring machine (TBM), hand tunneling or shield will be allowed, provided it can be demonstrated to City Engineer that proposed method will complete Project in accordance with Specifications, this Section, applicable safety codes, and Project schedules.
1. Contractor's Engineer responsible for design of primary tunnel liner system.
 2. Contractor responsible for final constructed product, materials and tools used, and for furnishing labor and qualified superintendents necessary for selected method of construction.
 3. Demonstrate that chosen method will prevent flow of water or soil into tunnel and provide stability of face under anticipated conditions.
- B. Use tunnel liner or casing of size so that minimum clearance between bottom of carrier pipe and inside of liner is minimum 4 inches, and minimum clearance between top of pipe and inside of liner or casing is in accordance with following:

<u>Carrier Pipe Net I.D.</u>	<u>Minimum Clearance to Top</u>
≥ 48"	9"
42"	7"
36"	5"
≤ 30"	3"

This clearance also applies to distance between carrier pipe and electrical conducting pipe support system.

- C. Furnish all items, such as TBM or shield with excavation equipment, spoil disposal systems, muck trains, hoist, grouting, signal systems, ventilation, safety equipment, and survey controls necessary to excavate and advance tunnel and construct primary tunnel liner by selected method.

2.02 LINER AND SUPPORTS

- A. The primary tunnel liner may consist of steel ribs and lagging, steel liner plates, precast concrete segments, steel casing pipe, or combinations of these. Lagging may be timber or steel. Box tunnels with timber supports or steel sets with timber lagging may be constructed when ground conditions are suitable. Utilize additional support elements including shotcrete, additional steel sets, breasting, spilling, forepoling, crown bars, soil anchors, or fabrics, as required to provide safe, stable excavation.
- B. Use steel liner plates, steel casing or steel lagging with steel ring beams as primary liner for tunneling under Texas Department of Transportation rights-of-way. Use steel casing as primary liner for tunneling under railroad rights-of-way. Timber lagging or timber falsework permitted in tunnels at other locations as shown on Drawings.
- C. Use steel casing as primary liner for tunneling in fault zone crossings.

2.03 MATERIALS

- A. Where use of following materials is required, conform to requirements of following minimum standards:

<u>Material</u>	<u>Reference Standards</u>
Cement	ASTM C150
Structural Concrete	See Section 03300
Reinforcing Steel Wire	ASTM A82 or A496
Reinforcing Steel Wire Fabric	ASTM A185 or A497
Reinforcing Steel Bars	ASTM A615, Grade 60
Sand and Aggregate	ASTM C33
Structural Steel	ASTM A36

Steel Piles, Sheets	ASTM A328
Rings and Ribs	ASTM A36
Steel Plates	ASTM A36 and A283
Lumber and Timber	Hardwood, sound or better, as defined by Commercial Standard C560
Steel Casing Pipe	AWWA C200

2.04 STEEL LINER PLATES

- A. Except as otherwise specified, furnish materials according to applicable requirements of AREMA Manual for Railway Engineering.
- B. Bolts and nuts: Conform to ASTM A307, Grade A. Use bolts no less than 1/2 inch in diameter for plate gauge 7 or thinner and no less than 5/8 inch in diameter for greater plate thicknesses.
- C. Punch plates for bolting on both longitudinal and circumferential seams and fabricate to permit complete erection from inside tunnel. Use plates of uniform fabrication and use interchangeable plates for those intended for one size tunnel.
- D. Use new material for construction of liner plates. City Engineer, at his option, may allow used plates provided that thickness of used plates after removal of rust is, at minimum, equal to thickness of new plates suitable for use on this Project; shape and dimensions meet acceptance tolerance for new plates; and used plates are free from other defects. City Engineer will determine acceptability of used plates.
- E. Provide steel liner plates manufactured by Contech Construction Products (2-flange), Commercial Pantex Sika, Inc. (4-flange), or approved equal, and certified by manufacturer of compliance with specifications. Provide tensile strength, yield strength and minimum elongation of liner plates. Also, provide design calculations for either 2-or 4-flange liner plates, as appropriate for Contractor's method of construction. All steel liner plate designs shall meet following minimum factors of safety:

$$\begin{aligned} \text{Seam Strength} &= 3 \\ \text{Buckling} &= 2 \\ \text{Maximum Deflection} &= 2\% \text{ (of normal tunnel diameter)} \end{aligned}$$

- F. Maintain minimum thickness of metal for these steel plates as shown on drawings, allowing for standard mill tolerances.
- G. Equip steel liner plates with approximately 2-inch-diameter grout holes furnished with plugs. Locate holes near plate centers, such that when plates are installed there will be one line of holes along crown and along each side of tunnel, not more than 18 inches above invert. Locate holes in each line at no more than every other plate and stagger.

- H. Protective coating not required for steel liner plates, unless otherwise specified or shown on Drawings.
- I. Install gaskets between liner plates when required to control seepage, or as specified or shown in Drawings.
- J. Steel ribs used with liner plates: Conform to requirements of Paragraph 2.05, Steel Beams and Lagging.

2.05 STEEL CASING PIPE

- A. Casing pipe: Provide new uncoated welded steel pipe, manufactured in accordance with AWWA C200.
- B. Design stress in pipe wall shall be 50 percent of minimum yield point of steel or 18,000 psi, whichever is less when subjected to loading conditions.
- C. Design deflection to be used in determining wall thickness shall not exceed 3 percent of nominal casing pipe size.
- D. Bedding constant to be used in determining wall thickness shall be 0.10. Lag factors shall be 1.0 for all live loads.
- E. Minimum thickness of steel casing shall be as shown on drawing. When casing is installed without benefit of protective coating, and said casing is not cathodically protected, increase wall thickness shown on drawings to nearest standard size, which is minimum of 0.0633 inches greater than thickness shown except for diameters under 12-3/4 inches.
- F. Casing pipe design shall also include stresses due to jacking forces when pipe is to be installed by jacking method.
- G. Equip casing pipe with approximately 2-inch diameter grout holes furnished with plugs. Place holes in pattern so that each succeeding hole from top dead center is 60 degrees right, then 60 degrees left, then top dead center. Locate holes in each line no more than 9 feet apart.
- H. Conform casing pipe used in fault zones to welding and weld testing requirements specified in Section 02502 - Steel Pipe and Fittings.
- I. Casing pipe used in fault zones must be plugged at each end with clay bricks around O.D. of pipe minimum of one foot thickness measured into casing to prevent infiltration of soil into annular space.

2.06 STEEL BEAMS AND LAGGING

- A. Steel ribs and auxiliary structural members shall be free of defects which may impair or reduce their structural integrity. Ribs shall be accurately curved to proper radius of tunnel section (or

shaft section) and rib segments shall fit closely for bolted connections at segmental and transverse joints. Provide steel appurtenances required for installation of ribs such as tie rods, bolts, splice plates, dutchmen and drift pins, with ribs.

B. Minimum factors of safety:

Buckling = 2

Stiffness = 3

2.07 FILTER FABRIC

- A. See Section 02621 - Geotextile for requirements of material and minimum installation requirements. Install fabric, and backer rods, as required to prevent loss of fine-soil sediments into tunnel.

2.08 TIMBER

- A. Use new timber for primary liner ground support without defects, of true dimensions and of quality grade and wood type defined by Contractor's Engineer.

PART 3 EXECUTION

3.01 PREPARATION

- A. Contractor shall be responsible for his means and methods of tunneling construction and shall ensure safety of work, Contractor's employees, public, and adjacent property, whether public or private.
- B. Execute work of excavating, lining, grouting, and construction of tunnel so that ground settlement or loss will be minimized. Completed primary tunnel lining shall have full bearing against earth with no voids or pockets left in work. Fill peripheral space between support elements and excavated surface no less frequently than after each shore or close by expanding support elements against ground as shield advances.
- C. Maintain clean working conditions inside tunnel and remove muck, debris, material spills, unusable supports, and other material not required for tunneling.
- D. Be aware that various existing soil borings, piezometers, or instrument wells may coincide with proposed tunnel alignment. These may or may not have been backfilled with grout and therefore caution should be used in tunneling through these existing borings. Take mitigating measures to counter effect these boreholes, piezometers, or instrument wells may have on tunneling operations.
- E. Perform tunneling under railroad embankments, highways, or streets to prevent interference with operation of railroad, highways, or streets.

- F. Do not perform any surface activities pertaining to water line construction within a tunnel area unless otherwise approved by City Engineer.

3.02 GROUND WATER CONTROL AND GROUND STABILIZATION

- A. Provide necessary ground water control measures to perform work and to provide safe working conditions. Prevent excessive inflow of water into excavation during construction of tunnel and installation of carrier pipe and grouting of annular space. Ground water control method shall provide means to prevent piping of fines into shafts or tunnel and other adverse effects due to ground water inflow. Additional requirements are included in Section 01578 - Control of Ground Water and Surface Water. Other methods of construction, including tunnel work under compressed air, may be considered when Contractor is able to demonstrate that it will prevent flow of materials or water into tunnel excavation and allows construction of work to meet requirements of drawings and specifications. Additional requirements are included in Section 01578 - Control of Ground Water and Surface Water.
- B. Anticipate that portions of tunnel excavation may be below ground water table and in cohesionless soils, even when not indicated on soil borings, and in conditions which may require ground water control system for tunneling operations. Install filter fabrics, backer-rods and other means as necessary to prevent piping of fines into tunnel. Remove water that may be encountered during course of work by pumping, well pointing, deep well pumping, or other means determined by Contractor as necessary to achieve stable conditions and applied in manner as described in Section 01578 - Control of Ground Water and Surface Water. Standing water not permitted at face, in tunnel or shafts.
- C. The ground water control method used shall not cause damage to adjacent structures or property due to lowering of water table and subsequent ground settlement. In event damage does occur, correct damage and settle claims arising from damage.
- D. If Contractor chooses pumping installations to control ground water level or installs pervious liner through water bearing layers, install and maintain instrumentation system to monitor water level and to detect movement in adjacent structures and property. Monitor water level by recording initial water level before dewatering is started and thereafter on weekly basis. Remove water monthly from piezometers to demonstrate that they are operable. Submit weekly reports of water levels to City Engineer. Provide access to piezometers for City Engineer to perform independent measurements.
- E. Maintain dewatering system for tunnels in continuous operation until minimum of 48 hours after carrier pipe has been installed and annular space is fully grouted, or until watertight liner designed for hydrostatic pressures is installed.
- F. If eductors, well points or deep wells are used, space them adequately to provide necessary dewatering. Use sand packing, and other means to prevent pumping of fine sands or silts from subsurface and to minimize ground subsidence. Check continuously to ensure that subsurface soil is not being removed by ground water control operation or subsurface drainage

into shafts or through pervious liner. Before operations begin, maintain availability of pumping equipment and other machinery on site to assure that operation of dewatering system can be maintained.

- G. When groundwater control is necessary, do not begin tunneling operations until monitoring data shows that it is safe to do so. When dewatering is sole means of ground water control, draw piezometric level at least down below elevation of invert of tunnel, or to lower elevation as required for excavation face and tunnel stability.

3.03 EQUIPMENT

- A. Tunneling method or equipment which Contractor can demonstrate based on past experience will produce specified results for soils encountered will be considered. However, use tunneling method, whether hand or machine, with full-face closure capabilities.
- B. Diesel, electrical, hydraulic, or air-powered equipment will be acceptable, subject to applicable Federal and State regulations. Diesel engines equipped with scrubbers are acceptable only when tunneling in free air with adequate ventilation. Provide compressed air and electricity for Contractor's operations from source outside tunnel.
- C. Tunnel Boring Machine: When tunnel boring machine is used, employ equipment that will be capable of handling various anticipated ground conditions. In addition, TBM shall:
 - 1. Be capable of minimizing loss of ground ahead of and around machine and providing satisfactory support of excavated face. Use TBM with, when necessary for ground control, earth-pressure balance or slurry-shield capabilities.
 - 2. Conform to shape of tunnel with uniform perimeter that is free of projections that could produce over-excavation or voids. TBM shield shall be continuous around its full perimeter; open-bottom shield is not acceptable.
 - 3. Have tail section long enough to enable setting of initial supports within machine, while still providing at least 12-inches of overlap beyond last installed support elements when thrusting jacks are extended to fullest extent possible.
 - 4. Have propulsion jacks capable of moving machine in forward direction while maintaining construction tolerances with respect to line and grade, without damage to previously-installed tunnel supports. Design propulsion system so that in event of failure of any element of system, there is no movement backward and there is no overstressing or distortion of tunnel supports.
 - 5. Incorporate seal in TBM tail shield to prevent leakage of grout between shield and liner into tunnel space, when grout is required immediately behind shield.
 - 6. Have motors and operating controls protected against water inflow.

7. Provide bi-directional drive on cutter head wheel, or fins or grippers to control roll due to rotation.
 8. Provide means for maintaining tunnel face under wet and adverse soil conditions. Use closure doors on cutter wheel or other means, such as earth-pressure balance or slurry shield, acceptable to City Engineer.
- D. Tunnel Shield: tunnel shield is used (with or without attached mechanized excavating equipment), employ shield that will be capable of handling various anticipated ground conditions. In addition, shield shall:
1. Conform to shape of tunnel with uniform perimeter that is free of projections that could produce over excavation or voids. Appropriately sized overcutting bead or taper along length of shield may be provided to facilitate steering. Shield shall be continuous around its full perimeter; open bottom shield is not acceptable. Although it is recognized that capability to over excavate beyond perimeter of shield may be necessary under certain conditions, make provisions to prevent accidental over excavation.
 2. Have hood, poling or breasting plates, shelves and breast jacks, breast tables, and combinations of these and other bracing as necessary to fully support face of tunnel excavation without loss of ground.
 3. Have tail section long enough to enable setting of initial supports within shield while still providing at least 12-inches of overlap beyond last-installed support elements when shield has been pushed forward to fullest extent possible.
 4. Have propulsion system for moving shield in forward direction, while maintaining construction tolerances with respect to line and grade, without damage to previously-installed tunnel support. Design propulsion system so that in event of failure of any element of system, there is no movement backward and there is no overstressing or distortion of tunnel supports.
 5. Have motors and operating controls protected against water inflow.
 6. Incorporate seal in tail of shield to prevent leakage of grout between shield and liner into tunnel space, when grout is required immediately behind shield.
- E. Air Quality: Provide equipment to adequately ventilate entire tunnel operation during construction.
1. Provide portable testing equipment for carbon monoxide gas, hydrogen sulfide gas, oxygen deficiency, and explosive gases. Monitoring for other constituents may be required while tunneling in potentially contaminated areas as defined in Contractor's safety plan.

2. Provide audible automatic gas alarm on TBM to detect explosive gases. Locate alarm near tunnel face.
 3. Equip motors and controls with automatic shutoff methane monitoring system.
- F. Lighting: Provide adequate lighting with lights at 50 feet, maximum spacing in tunnel. Fixtures shall be in watertight enclosures with suitable guards. Provide separate circuits for lighting and for electrical equipment.
- G. Electrical: Equip electrical systems utilized on TBM with appropriate ground fault system. Electrical systems are to be insulated, not permitting bare-wire exposures.
- H. Access: Provide safe access through tunnel to TBM.
1. Provide walkway in tunnels greater than 10 feet in diameter which is separate from tracks used by spoil removal equipment.
 2. Equip locomotives or cars used for transport of personnel with necessary safety devices.
- I. Necessary equipment for tunnel excavation includes telephones, signal systems, fire extinguishers, safety equipment, and other equipment required by Contractor's method of construction, work plan and safety plan. Maintain equipment in good repair, and readily available at place of work.

3.04 SHAFTS

- A. Construction of Shafts: Conform work for all shafts, with or without permanent structures in them, to requirements of Section 02400 - Tunnel Shafts. Contractor responsible for selecting shaft locations in agreement with his planned method of tunneling and for sizing shafts.

3.05 TUNNEL EXCAVATION AND PRIMARY LINER INSTALLATION

- A. Tunnel Excavation:
1. Methods of tunnel excavation at Contractor's option, subject to review of City Engineer.
 2. Conduct tunneling operations in accordance with applicable safety rules and regulations, and Contractor's safety plan. Use methods which include due regard for safety of workmen, adjacent structures, utilities, and public.
 3. Limit tunnel excavation to within easements and rights-of-way indicated on Drawings, and to lines and grades designated on Drawings. Perform excavation of sufficient size to allow installation of water line to lines and grades indicated on Drawings.
 4. Locate equipment powered by combustible fuels at suitable distances from shafts to prevent possibility of explosion and fire in shafts or tunnel.

5. During open-face excavation:
 - a. Excavate face commencing at crown and proceed down to invert. Excavate both sides of heading simultaneously. Keep hood buried in soil ahead where soils include sands and silts.
 - b. Keep face breasted or otherwise supported; employ other means as necessary to maintain face stability and prevent falls, excessive raveling, or erosion. Maintain standby face supports for immediate use when needed.
 - c. During shut-down periods, support face of excavation by positive means; do not rely solely on hydraulic pressure for support. When face is untouched for more than 24 hours, and when required by City Engineer, fully breast face and shove shield tight against it.
 6. During closed-face excavation:
 - a. Carefully control and monitor volume of spoil removed. For earth-pressure balance TBM, balance spoil removed with advance rate and excavation rate.
 - b. When cutting face is withdrawn, keep excavated face stabilized as required.
 7. Advancing Shield: During forward movement of shield, provide sufficient support at excavation face to prevent movement of materials except materials as are physically displaced by elements of shield itself.
- B. Size of Tunnel: Determine adequate tunnel size and section to match construction methods described in work plan. Build tunnels of sufficient size to permit efficient excavation operations, to provide sufficient working space for placing primary tunnel liner, and to allow for installation of water line as shown on Drawings or indicated in Specifications. Dimensions shown on Drawings represent minimum dimensions acceptable to City Engineer and do not necessarily represent size or section suitable for construction methods or operational procedures as may be proposed or conducted by Contractor.
- C. Primary Liner:
1. Provide primary liner for tunnel which is capable of supporting ground, and hydrostatic forces until permanent water pipe has been installed and grouted in place, and to resist construction loads.
 2. Use methods that ensure full bearing of soil against primary liner without significant settlement or movement of surrounding soil. To fill void behind primary liner, either expandable liner (e.g., ring beams and timber lagging) or nonexpandable liner (e.g., bolted steel liner plates) may be used provided grout is placed behind nonexpandable

liner. Box tunnel where ground is excavated to true shape may be ungrouted. Grout excavation not to true shape as result of careless excavation or loss of ground.

3. The primary liner's seepage inflow for each 100-foot length of tunnel shall not exceed 3 gallons per minute, including inflow through face or shield. Localized inflow shall not exceed 0.5 gallons per minute. Provide drainage facilities to remove inflow of water from tunnels and shafts. Provide means to prevent inflow of soil fines associated with water inflow by use of filter fabrics or other approved methods.
4. Expandable liner shall be continuous and shall be expanded to limits of excavation promptly after it is out of shield.
5. During excavation of tunnel, advance TBM or shield only far enough to permit construction of one primary liner ring beam set, or rings of bolted steel liner plates that can be assembled entirely within tail shield of TBM.
6. Install filter fabric around exterior of primary liner when using non-watertight liner and when tunneling through sandy or silty ground conditions. Install backer rods at ribs as required to control migration of fines. Close windows in lagging.
7. Provide hog rods, struts or similar members when required to maintain roundness. After grouting liner shall be no more than 3 percent out of round as measured by difference between maximum and minimum measured diameter divided by average diameter.

D. Hand Jacking of Casing:

1. Provide heavy-duty jacks of capacity suitable for forcing casing pipe through ground. Construct operating jacks so that even pressure is applied to all jacks used. Provide suitable jacking head, (timber, etc.), and suitable bracing between jacks and jacking head. Provide suitable jacking frame and/or back stop. Set casing pipe to be jacked on guides, (timber, etc.), properly braced together, to support section of pipe and direct it to proper line and grade. Place whole jacking assembly so as to line up with direction and grade of casing pipe.
2. Excavate ground material just ahead of casing pipe by use of air-powered tools, excavating machine or other acceptable means, and remove through casing pipe. Then force casing pipe through ground with jacks, into space thus provided. Dispose excavated material as specified.
3. Trim excavation in manner so that at least one third of circumference of excavation conforms to contour and grade of casing pipe. Provide clearance of not more than 2 inches for upper half of casing pipe with clearance tapering off to zero at point where excavation conforms to contour of casing pipe. cutting edge of steel plate installed around head end of casing pipe extending short distance beyond end of casing pipe with

inside angles or lugs to keep cutting edge from slipping back onto casing pipe may be used.

4. In addition to requirements set for in this specification, Contractor shall:
 - a. Excavate face commencing at crown and proceed down to invert. Excavate heading so that both sides of heading are excavated simultaneously.
 - b. At all times maintain standby face supports to allow for immediate use when needed.
 - c. At end of each shift and whenever excavation is suspended or shut down, install breast boards, or other approved methods, across full face of heading.
5. Distance that excavation extends beyond end of casing pipe shall not exceed three feet. Decrease this distance as directed by Engineer, or due to character of material being excavated.
6. The casing pipe, insofar as practical, jack from low or downstream end. Lateral or vertical variation in final position of casing pipe from line and grade as established by Engineer will be permitted only to extent of 1 inch in 10 feet, provided that variation is regular and only in one direction and that final grade of flow line is in direction indicated on plans. Remedy overcutting by pressure grouting entire length of installation. Use of grout mix immediately behind shield tail shall have efficient tail seal to prevent flow of grout into shield.
7. Depending on character of soil encountered during jacking operation, carry on operation without interruption, insofar as practical, to prevent casing pipe from becoming firmly set in ground.
8. Remove and replace casing pipe damaged in jacking operations by Contractor at no additional cost to Owner.
9. Backfill pits or trenches which have been excavated to aid jacking operations as soon as casing pipe is complete in place, equipment and appurtenances have been removed and structure, which is to be built in excavated zone, is in place. In no case shall pits remain open without appropriate safety barricades, concrete traffic barriers (CTB's), railing or plates.
10. When jacking casing pipe, water jetting of casing pipe bedding or backfill is not allowed. In unconsolidated soil formations, use gel-forming colloidal drilling fluid consisting of at least 10 percent of high grade fully hydrated bentonite to seal voids outside walls and furnish lubrication for installation of casing pipe.

E. Grouting:

1. Furnish and operate suitable equipment for grouting operations to effectively and completely fill voids outside of primary tunnel liner as quickly as possible.
2. Additional requirements pertaining to grout mix design and tunnel grouting are provided in Section 02431 - Tunneling Grout.
3. Provide in tunneling work plan description of primary liner grouting operations, including:
 - a. Arrangement of grouting equipment including mixer, pumps, piping and hoses, valves, pressure gauges and injection fixtures.
 - b. Location, spacing and size of grout ports and vents.
 - c. Grouting sequence for initial backfill of voids between liner and ground, and for second stage back grouting.
 - d. Grout injection pressures and estimated volumes.
 - e. Procedure to check for remaining voids.
 - f. Sampling procedures and locations for quality control testing.
 - g. Grout production and quality shall be in accordance with Contractor's mix design and grout production plan as required by Section 02431 - Tunneling Grout.
4. Use care in grouting operations to prevent damage to adjacent utilities or other properties. Ensure that pressure used in grouting is not great enough to distort or imperil work.
5. Fill voids behind nonexpandable primary liner with sand-cement grout promptly after liner is out of shield. Grout pressure shall not exceed value that may cause damage or distortion to installed liner plate rings. Grout from bottom up and plug each grout hole promptly after grout has been placed. Provide seals on tail of TBM which will prevent grout from moving into shield.
6. Liner requiring grout shall be back grouted (second stage grouting) once each shift, or more often when required to ensure that all voids are filled.
7. Place grout behind tunnel liner at end of each day or at every 10 feet of tunnel installed, whichever is less, unless in opinion of Engineer, ground conditions are such as to require each ring to be grouted immediately after erection. Upon completion of each grouting operation, sound primary liner and immediately correct voids discovered by necessary means as approved by Engineer. After all voids are successfully filled, grout

holes will be packed, when necessary, with dry mortar mix and threaded taps securely placed in holes.

8. Completely and immediately fill voids outside limits of tunnel excavation created by caving or collapse of earth cover over excavation, or by other cause, with sand cement grout. Perform second grouting to fill soft spots or voids which may be detected, no later than 24 hours after initial grouting of primary liner.
9. Perform quality control sampling and testing of grout.
 - a. Grout production shall be in accordance with Section 02431 - Tunneling Grout.
 - b. Measure density of grout throughout placement procedure as directed by City Engineer. Measure grout density at discharge point and discharge grout until density is within 0.3 pounds per gallon of input density.
 - c. Take samples of well-mixed grout for 28-day compressive strength tests at beginning, middle and end of each grouting operation.

3.06 TUNNELING DATA

- A. Submit shift logs of construction events and observations within 24 hours of operation on at least following:
 1. Location of face by station and progress of tunnel drive during shift.
 2. Observation of lost ground and other signs of ground movement.
 3. Location and elevation of significant soil strata boundaries and brief soil descriptions.
 4. Ground water control operations, piezometric levels, ground water inflow location and rates.
 5. Completed field forms for establishing and checking line and grade and achieved tolerance relative to design alignment.
 6. Operation shut-down periods or other interruptions in work, and reason.
 7. Any unusual condition or event.
- B. Clearly mark primary liner every 20 feet along tunnel with distance in feet from centerline of preceding shaft.

3.07 CONTROL OF TUNNEL LINE AND GRADE

- A. Construction Control:

1. The City Engineer will establish baseline and benchmarks indicated on Drawings. check these baseline and benchmarks at beginning of work and report errors or discrepancies to City Engineer.
2. Use baseline and benchmarks established by City Engineer to furnish and maintain reference lines and grades for construction. Use these lines and grades to establish location of tunnel, water line, and structures.
3. Establish and be fully responsible for accuracy of controls for construction of Project, including access shaft locations, structures, tunnel line, and grade. Utilize laser to insure line and grade are maintained during tunneling process.
4. Establish control points sufficiently removed from tunnel operation not to be affected by potential ground movement.
5. maintain daily surveying records of alignment and grade and submit three copies of records to City Engineer by end of day after work performed. Locate points at top, bottom and each side of springline.
6. check tunnel survey control against aboveground undisturbed reference at least once each week and once for each 250 feet of tunnel constructed, or more often as needed or directed by City Engineer.

B. Earth Movement: Contractor responsible for damages due to settlement from construction-induced activities or occurrences.

1. Take precautions to avoid damage or settlement to buildings, structures, roads, and utilities to work in proximity of tunnel. Minimum precautions to include use of construction methods and equipment to minimize loss of earth at tunnel face and settlement of soil around primary tunnel liner.
2. Refer to Paragraph 3.09, Monitoring for detecting earth movement.
3. In event movement of ground is detected, City Engineer may order work stopped and secured. Before proceeding, correct problems causing or resulting from movement.
4. Be aware that when settlement of ground surface should occur during construction of tunnel which will affect accuracy of temporary benchmarks established by City Engineer, detect and report movement. Locations of permanent City of Houston monumentation benchmarks are indicated on Drawings; Contractor may use these to verify temporary benchmark accuracy. Advise City Engineer of settlement affecting permanent monumentation benchmarks. Upon completion, submit field books pertaining to monitoring of permanent monumentation benchmarks to City Engineer.

C. Tunnel Line and Grade:

1. Survey crown, invert, and springline on each side of primary liner at 50-foot intervals, or minimum of once per shift, or more frequently when line and grade tolerances have been exceeded, to ensure alignment is within tolerances specified. Conduct survey immediately behind tunnel excavation to allow immediate correction of misalignment.
2. When excavation is off line and grade, make corrections to plan line and grade at rate of 3 inches per 100 feet.
3. Control excavation of tunnel and construction of primary liner to allow construction of carrier pipe within 6 inches on line and 4 inches on grade and to maintain circular shape of tunnel.
4. Alignment adjustments between primary tunnel liner and water main shall not encroach on minimum required clearance of 4 inches defined in Section 02517 - Water Main in Tunnels.
5. If unable to maintain specified tolerances, bear full responsibility and expense of correction (redesign, easement acquisition, etc.) when these tolerances are exceeded and redesign of structures is required, obtain services of qualified Professional Engineer registered in the State of Texas for redesign. Submit plans showing changes to City Engineer for review.
6. Backfill (grout) and reconstruct tunnel built outside tolerance or which is outside City's right-of-way to be within tolerance when so directed by City Engineer.

3.08 TUNNEL CONNECTIONS, TERMINATIONS, AND TEMPORARY BULKHEADS

- A. Connect new tunnels to existing structures by removing existing bulkheads, when necessary, and sealing junction as shown on Drawings.
- B. Seal terminations of tunnels, which are not connected to permanent structures, by temporary bulkhead.
- C. Design temporary bulkheads where and when required and obtain City Engineer's acceptance of design prior to constructing it. Provide bulkheads capable of resisting lateral earth and hydrostatic pressures, waterproof, and capable of being removed without damaging water line or plastic liner.

3.09 MONITORING

- A. **Monitoring Instrumentation:** This specification establishes minimum instrumentation requirements for tunneling. Additional instrumentation requirements for critical areas may be specified elsewhere in Specifications or on Drawings. Contractor may install more extensive system at Contractor's sole expense. Instrumentation specified shall be accessible at all times to City Engineer.

1. Submit for review, prior to construction, Monitoring Plan including instrument installation design, instrumentation points location and layout, manufacturer's catalog literature, installation report formats.
 2. Install and maintain system of instrumentation to monitor tunneling operation and to detect movement in soil and adjacent structures. Instruments shall consist of no less than sufficient number of inclinometers and crack monitors at bridge and adjacent structures and sufficient piezometers. Use monuments sufficiently removed from construction to avoid errors in readings due to ground settlement.
 3. Installation of instrumentation by Contractor shall not preclude City Engineer, through independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Provide access to work for independent installations.
 4. Install soil instruments such as piezometers, inclinometers, extensometers, and crack monitors by qualified subcontractor specializing in geotechnical work.
 5. Install extensometers to depth of 5 feet above crown of water line tunnel as shown on Drawings to measure vertical movements in soils during and subsequent to tunneling. Extensometer consists typically of three-prong anchor, 1/4-inch standard stainless steel inner pipe, and 1-inch standard Schedule 80 PVC outer pipe. Pipes are assembled in sections and fastened together with standard couplings to required anchor depths. Locate top of extensometer within flush-mounted hand hole cover capable of withstanding HS-20 truck loading. Geotechnical instrumentation installation subcontractor shall provide procedures for installation of extensometers as part of Monitoring Plan.
- B. Building and Structures Assessment: Submit for review prior to construction, Building and Structures Assessment Plan. Provide preconstruction and post-construction assessment reports for buildings and structures located within distance equal to depth of tunnel but at least 50 feet in plan from proposed tunnel centerline and shafts. Include photographs or video of existing damage to structures in vicinity of water line alignment in assessment reports.
- C. Settlement Surveying: This specification establishes minimum settlement survey requirements for structures and ground surface monitoring points.
1. Submit settlement surveying and monitoring plan for review prior to construction. Plan shall identify location of settlement monitoring points, reference benchmarks, survey schedules and procedures and reporting formats.
 2. Locate survey points on all structures within distance equal to depth of tunnel but at least 50 feet in plan from tunnel centerline.
 3. Record horizontal coordinates and elevations (with accuracy of 0.01 feet) for each survey point location. Reference survey points so that they may be accurately re-established when lost or destroyed.

4. Unless otherwise specified, record ground surface elevations on center line ahead of TBM and at 20 feet either side of center line at minimum of 100-foot intervals or at least three locations per tunnel drive. Starting 100 feet ahead of TBM and continuing until TBM is 100 feet beyond measurement point or until further movement is not detected, unless otherwise directed by City Engineer. Record cross-sectional points at 10-foot spacing for distance of 50 feet each side of center line or to ROW, whichever is less.
 5. Locate survey points at crossings under installations as follows:
 - a. Roads: Centerline and each shoulder.
 - b. Railroad: Track subbase at centerline of each track.
 - c. Utilities and Pipelines: Directly above and 10 feet before and after intersection.
 6. For shaft settlement see Section 02400 - Tunnel Shafts.
- D. Measure and maintain records of deformation of primary liner.
- E. Reading Schedule and Reporting: Submit readings from various instruments and survey points weekly to City Engineer. Take daily Readings as required by City Engineer when construction is approaching or near critical structures (structures, bridge piers, pipelines, etc., partially or entirely located within distance equal to depth of tunnel but at least 50 feet in plan from tunnel centerline). Take initial readings of surface points before excavation or construction is started.
1. Immediately report to City Engineer movement, cracking, or settlement which is detected and take immediate remedial action. Contractor shall be fully responsible for damage to adjacent structures.
 2. At end of construction after water line is installed, and dewatering is discontinued, make final survey of control points established for instrumentation and observation. Submit final readings to City Engineer. Make visual inspection of structures adjacent to water line and report to City Engineer condition of structures, damage incurred during construction, and corrective action taken.
- 3.10 DISPOSAL OF EXCESS MATERIAL
- A. Remove spoil from job site and dispose in accordance with Section 01504 - Temporary Facilities and Controls.

END OF SECTION

Section 02511S

WATER LINES

The following supplement modifies Specification Section 02511 –Water Lines. Where a portion of the Specification is modified or deleted by this Supplementary Specification, the unaltered portions of the Specification shall remain in effect.

3.06 JOINTS AND JOINTING

Delete paragraph 3.06.C.13.d., and replace with the following:

3.06.C.13.d. For all field welds, employ an independent certified testing laboratory, approved by Project Manager, to perform weld acceptance tests on welded joints. Furnish copies of test reports to Project Manager for review. Project Manager has final decision as to suitability of welds tested.

Sub-paragraphs 1) a. and b. remain unchanged.

END OF SUPPLEMENT

Approved by:

Arthur Morris, P.E.
Managing Engineer
Water Engineering Section
Engineering and Construction Division

Date

Section 02513S

WET CONNECTIONS

The following supplements modify Specification Section 02513 – Wet Connections. Where a portion of the Specification or Detail is modified or deleted by this Supplementary Specification, the unaltered portions of the Specification shall remain in effect.

1.03 REFERENCES: Add the following Paragraph B:

- B. OSHA 29 CFR 1926.1101 – Asbestos.

Add the following new Paragraph:

3.03 CONNECTION TO ASBESTOS-CEMENT (AC) PIPE

- A. Notify Project Manager when AC pipe is encountered.
- B. Refer to Section 02221 – Removing Existing Pavements and Structures for crew training, safety precautions, and AC pipe removal requirements.
- C. Protocol:
1. Mechanically excavate to no more than 6 in. of AC Pipe. Carefully uncover the remainder of pipe by hand or with shovel.
 2. Keep pipe adequately wet before and during work.
 3. Place 2 layers of 6 mil polyethylene sheeting under the asbestos pipe to prevent soil contamination.
 4. Use hand tools to remove collars. Replace minimum 6 ft. section of pipe. Use of power tools is prohibited.
 5. Do not crush AC pipe in place. Remove waste AC pipe.

END OF SUPPLEMENT

Approved by:



Mark L. Loethen, P.E., CFM, PTOE
City Engineer
Department of Public Works & Engineering

11/17/2012

Date

Section 02514S

DISINFECTION OF WATER LINES

The following supplement modifies Specification Section 02514 – Disinfection of Water Lines. Where a portion of the Specification is modified or deleted by this Supplementary Specification, the unaltered portions of the Specification shall remain in effect.

- 1.02 MEASUREMENT AND PAYMENT: Delete paragraphs 1.02A and 1.02B and replace with the following and reorder the remaining paragraph:
- A. Unit Prices:
1. Disinfection of large diameter water lines installed is incidental to the work.
 - a. New water line also includes sliplined water lines.
 2. Payment for disinfection of existing large diameter water lines under this Section will be made on a linear foot basis, regardless of diameter, when performed as described below:
 - a. Pressure washing interior of line.
 - b. Swabbing of pipe interior with chlorine solution or adding chemical disinfectant.
 - c. Locate and maintain blow-offs to maintain drainage and prevent flooding during flushing.
 3. No separate payment will be made for:
 - a. Disinfection operations performed by City crews.
 - b. Installing temporary blow-off piping from existing outlets, on both small and large diameter water lines.
 - c. Disinfection and flushing of newly installed small diameter water lines.
 - d. Routing any produced flushing water to City of Houston storm sewer inlets.
Chlorinated flush water will NOT be allowed into any TxDOT drainage facilities.
 4. Existing air valve removal and replacement required will be paid under separate Bid Items.
 5. Water for flushing obtained from water line work is performed will be provided at no cost.
 6. Permanent 2-inch blow-offs installed within surface meter box on a new existing small diameter water lines will be paid separately, if required in Work Order.

7. Refer to Section 01270 – Measure and Payment for unit price procedures.

3.01 CONDUCTING DISINFECTION. Delete Article 3.01 and replace with the following:

- A. If requested, Contractor will perform disinfection operations. Contractor is responsible for providing all necessary equipment, materials, labor, and tools needed to perform disinfection operations.
- B. City will furnish water for disinfection and flushing without charge. Water for disinfection and flushing may be supplied through proposed connection to existing distribution system provided City controls the flushing procedure, sequencing, and operation of valves.
- C. Coordinate chlorination operations through Project Manager. Contractor will limit disinfection and flushing operations to the following time periods to reduce potential service disruptions during daytime hours.
 - 1. Supply lines larger than 16-inch: 7:00 p.m. to 6:00 a.m.
 - 2. Supply lines 16-inch and smaller: 12:00 a.m. to 6:00 a.m.

3.02 PREPARATION. Delete Article 3.02 and replace with the following:

- A. Provide temporary blind flanges, cast iron sleeves, plugs, necessary service taps, copper service leads, risers and jumpers or sizes, location, and materials, and other items needed to facilitate disinfection of new water lines prior to connection to City water distribution system.
- B. Install 6-inch blow off assemblies at the end of each section and 3-inch blow off assemblies every 1000 feet to ensure adequate flushing velocities and remove temporary assemblies promptly upon successful completion of disinfection and testing.
- C. Conduct a physical inspection of the pipeline and pressure wash entire pipe interior to remove any loose debris and ensure that it is clean prior to filling and disinfection.
- D. Notify Project Manager of the schedule for final walk through inspections prior to filling of line.
- E. Layout plastic sheeting around work area. All personnel, equipment and material shall be cleaned on plastic-covered area prior to entering pipe.
- F. Use spray applicator to apply a 1% solution of sodium hypochlorite to the interior pipe surface. Swab interior of pipe and underside of access manway flange.
- G. Add chemical HTH crystals along the section of pipe to be disinfected prior to filling for disinfection.

- H. Slowly fill each section of pipe with water in manner approved by Project Manager. Average water velocity when filling pipeline should be less than one foot per second and shall not, under any circumstance, exceed 2 feet per second. Before beginning disinfection operations, expel air from pipeline.
- 3.04 DISINFECTION BY CONTRACTOR. Delete paragraph 3.04 A. 3. and replace with the following.
- A. After contact period of not less than 24 hours, flush system with clean water until residual chlorine is no greater than 1.0 parts per million parts of water. Target chlorine residual for flushing is 25 ppm to 50 ppm. Should chlorine concentration exceed this residual, Contractor is to dechlorinate the water prior to discharge.
- 3.06 COMPLETION: Delete Paragraph 3.06 A and replace with the following:
- A. Upon satisfactory completion of disinfection and hydrostatic testing, remove risers and cap directly at the water line. Do not leave any portion of riser extending from water line. Backfill excavation promptly. Show blow-off locations on as-built record drawings, and note the type of cap used. If blow-off location is underneath pavement, comply with the following:
1. If pavement is restored prior to completion of disinfection and hydrostatic testing, install temporary pavement over blow-off. Comply with Street Cut Ordinance for dimensions of temporary pavement.
 2. Backfill excavation with select fill or cement stabilized sand in accordance with Section 02320 – Utility Backfill Materials and Section 02317 – Excavation and Backfill for Utilities.

END OF SUPPLEMENT

Approved by:

Arthur Morris, P.E.
Managing Engineer
Water Engineering Section
Engineering and Construction Division

Date

Section 02519

**ASSESSMENT AND
REHABILITATION OF EXISTING WATER LINES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Rehabilitation and replacement of existing pipe and appurtenances.
- B. Leak detection and leak location.
- C. Internal and external rehabilitation of large diameter water lines.
- D. Contractor support for the City or their assigned representatives to perform internal Condition Assessment of existing large diameter water lines.

1.02 MEASUREMENT AND PAYMENT

- A. Payment for leak detection will be paid by lump sum basis. Payment includes:
 - 1. Mobilization of leak detection Contractor.
 - 2. Leak detection, report and findings to Project Manager.
 - 3. Air release valves (ARV's) or blind flanges required to be removed for leak detection will be paid separately.
- B. Payment for dewatering will be paid per linear foot
 - 1. Price includes the draining of existing water lines, vaults and other appurtenances necessary to perform work. Utilize adequate size and number of pumps needed to remove water in a timely manner. Anticipate using a 6-inch pump at each low point in the line for large diameter water line work. Monitor the pumping rates to avoid the flooding of any private property, streets or sidewalks.
 - 2. Existing water line may be partially dewatered by gravity using drain outlets; however, much of the effort will require pumping from within the pipe. In order to maneuver pump suction hoses or submersible pumps into low areas in the line, anticipate manned entry, and pumping in stages to lower the water level.
 - 3. Anticipate continuous pumping due to leaky valves that may require periodic or continuous pumping during work.
- C. Payment for removing and replacing access manway flange is on a unit price basis for each access manway flange removed and replaced. Payment includes the following:
 - 1. Removal and disposing of existing access manway flange/cover; includes removal of blind flange cover bolts and nuts, removal of blind flange cover, removal of gasket. Existing flanges may be 18-, 20- or 24-inch diameter.
 - 2. Access Manway Flange
 - a. Installation of new flange/cover with matching dimensions with 6-inch flanged outlet and gate valve; includes installing new blind flange cover with new bolts, nuts and gaskets. New blind flanges may be 18-, 20- or 24-inch diameter, and should match existing flange removed.

3. If deemed acceptable by Project Manager, existing flange may be cleaned, retrofitted as needed (to provide 6-inch outlet and gate valve, and baffle removed), recoated and reused, at the same cost.
- D. Payment for Internal Water Line Rehabilitation will be paid by each installed:
1. Payment is on a unit price basis for each 84-inch Internal Large Diameter Joint Renewal System, AMEX-10/WEKO-SEAL (extra-wide w/ two Type 304 SS retaining bands) by Miller Pipeline, or approved equal, installed. Includes effort to clean and repair loose or damaged grout, remove rust and scale, install and test seal. Each seal should be air tested to a minimum of 5 psi prior to acceptance.
 2. Payment also includes any necessary work (butt-strap, welding and filler rods/bars) to install WEKO-SEAL(s).
 3. Extra Unit Price Items are also included if additional joints are needed to be repaired.
- E. Payment for External Water Line Rehabilitation will be paid by each installed:
1. Unit Price Work Items for each exterior joint welded on an existing 84-inch steel water line by open trench.
 2. Payment includes certified welder and any necessary steel filler rods or bars to complete weld closure, as well as removing and replacing water line coating.
 - a. Existing 84-inch water line coating may be tape, epoxy or both. Any coating removed or damaged during construction to be replaced, no separate pay. Steel water line coating to comply with Section 02518 – Steel Pipe and Fittings for Large Diameter Water Lines.
 3. Excavation, trench safety and ground water control is incidental to this Work.
 4. Extra Unit Price Items are also included if additional joints are needed to be repaired.
- F. Refer to Section 01270 - Measurement and Payment for unit price procedures.
- G. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ANSI A 21.11/AWWA C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- B. ANSI/NSF Standard 61 - Drinking Water System - Health Components.
- C. ASTM A 36 - Standard Specification for Carbon Structural Steel.
- D. ASTM A 536 - Standard Specification for Ductile Iron Castings.
- E. ASTM A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- F. ASTM B 21 - Standard Specification for Naval Brass Rod, Bar, and Shapes.

- G. ASTM B 98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
- H. ASTM B 301 - Standard Specification for Free-Cutting Copper Rod and Bar.
- I. ASTM B 584 - Standard Specification for Copper Alloy Sand Casting for General Application.
- J. ASTM E 165 - Standard Test Method for Liquid Penetrant Examination.
- K. ASTM E 709 - Standard Guide for Magnetic Particle Examination.
- L. ASTM F 1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
- M. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.
- N. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches through 144 Inches.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Conform to submittal requirements of applicable Section for type of pipe used.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

- A. Install pipe materials which conform to following:
 - 1. Section 02501 - Ductile Iron Pipe and Fittings.
 - 2. Section 02507 - Prestressed Concrete Cylinder Pipe.
 - 3. Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines.
 - 4. Section 02613 - Bar-Wrapped Steel Cylinder Pipe.
- B. Conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and have certified by an organization accredited by ANSI.
- C. Type of pipe materials shall match existing pipe, unless specifically identified on Drawings.

PART 3 EXECUTION

3.01 PREPARATION

- A. Conform to applicable installation specifications and details for types of pipe used.
- B. Employ workmen who are skilled and experienced in laying pipe of type and joint configuration being furnished.

3.02 GENERAL REQUIREMENTS

- A. Leak Detection
 - 1. Contractor to perform Leak Detection is to have conducted at least five (5) inspections within the past two (2) years.

- B. Excavation around existing pipe:
1. When excavating around an existing large diameter water line, follow requirements described in Specification Section 02317.
 2. Excavate the shore trench a width of at least 4 feet wider than pipe, and 4 feet longer than the length of pipe to be exposed to permit observations of circumference of pipe.
 3. Provide field surveyed (horizontal and vertical elevations) "as-builts" existing underground utilities encountered and all new work installed.
- C. Removal of existing pipe:
1. Where directed to remove existing pipe sections cut around the circumference of the existing pipe, whether with saw, torch, or other means.
 2. For PCCP, no partial pipe sections may be removed. Completely remove an entire section of pipe between existing joints. Remove pipe section without damaging adjacent pipe joints. Contractor shall be responsible for repairing damage caused by their work to existing pipe not intended for removal.
 - a. All "cuts" must be made on pipe sections intended to be removed. The entire bell or spigot on pipe sections to remain in place should not be disturbed.
 3. Only one pipe section may be cut at a particular location, unless approved by Engineer, regardless of how many are removed. Once the first section is cut and removed, the adjacent pipe sections to be removed (if any) shall be pulled from their joints intact.
 4. All new pipe to be designed, manufactured and installed in accordance with Specification Section 02511, and with materials compatible with the existing pipe. For example, for replacing and existing PCCP, mortar coated and lined steel pipe with ends built up to match PCCP bells and spigots shall be used.
- D. Pipeline Dewatering (Draining) and Cleaning:
1. Utilize adequate size and number of pumps needed to remove water in a timely manner and to maintain no more than 12-inches of water.
 2. Provide continuous pumping as needed due to leaking valves that may be required to keep water line dewatered during internal inspection.
 3. Avoid surface runoff or groundwater from entering water line.
 4. The pipe shall be dewatered and accessible for a minimum of fourteen (14) full working days, Monday through Friday, between 8:00 AM and 5:00 PM, excluding City holidays, as allowed by traffic control plans and water line shut down requirements.
 5. Contractor shall schedule the dewatering of each phased segment of pipe for condition assessment as early as possible within the waterline shutdown period and shall provide a minimum of four (4) business days (excluding holidays) prior written notice of when the phased segment will be dewatered and ready for safe confined space entry for the City's condition assessment.

6. Each section of water line required to be cleaned shall be pressure washed
 - a. Limit pressure washing to less than 500 psi spray. The spray pressure should be monitored and adjusted as necessary to clean the pipe interior without damaging joint grout and mortar lining of the pipe.
 - b. Wash water is to be disposed of lawfully using a vacuum truck, or other approved method, avoiding discharge into any City storm facility or Harris County Flood Control drainage facility, unless prior approval is granted.
- E. Internal manned entry:
 1. Provide positive shut-off and lockout-tagout of all valves prior to entering pipe.
 - a. It is preferred to provide two valve shutoff (two valves closed between the work zone and source of water pressure), whenever possible. In this case, it is also preferred to relieve the pressure between the two closed valves (but not drain water from the pipe between the valves).
 2. Provide confined space entry support to City and their representatives for internal manned entry.
 - a. Provide certified attendants at each surface access point within the limits to be assessed. Attendants shall be able to communicate with assessment crew at all times.
 - b. Provide confined space safety equipment for City or their representatives (at least 3 people) intended the specific spaces to be entered. Verify calibration and expiration dates on all equipment.
- F. Joint Grout (Prestressed Concrete Cylinder Pipe, Bar Wrapped Pipe, Mortar Coated or Lined Steel Pipe):
 1. The City or their representative will identify existing joints for regrouting.
 2. Clean joint of all loose or damaged grout, rust, scale, or other debris, and wire brush to clean steel surfaces where accessible.
 - a. Make note of existing joint type (welded, O-ring gasket, etc., and whether joint bonding clips or cables are present. Provide this information to the Project Manager before installing grout, and document in “as-built” drawings.
 - b. If directed, install new joint bonding devices in accordance with Specification 15640 – Joint Bonding and Electrical Isolation.
 3. Prepare grout in small batches to prevent stiffening before it is used. Do not use grout which has become so stiff that proper placement cannot be assured without retempering. Use grout for filling grooves of such consistency that it will adhere to pipe.
 4. Surface Preparation: Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces with wire brush or hammer to sound, clean surface. Remove rust and foreign materials from metal surfaces in contact with grout.

5. Grouting Exterior Joint Space: Hold wrapper in place on both sides of joint with minimum 5/8-inch-wide steel straps or bands. Place no additional bedding or backfill material on either side of pipe until after grout band is filled and grout has mechanically stiffened. Pull ends of wrapper together at top of pipe to form access hole. Pour grout down one side of pipe until it rises on other side. Rod or puddle grout to ensure complete filling of joint recess. Agitate for 15 minutes to allow excess water to seep through joint band. When necessary, add more grout to fill joint completely. Protect gap at top of joint band from backfill by allowing grout to stiffen or by covering with structurally protective material. Do not remove band from joint. Proceed with placement of additional bedding and backfill material.
6. Interior Joints for Water Lines: Clean joint space, wet joint surfaces, fill with stiff grout and trowel smooth and flush with inside surfaces of pipe using steel trowel so that surface is smooth. Accomplish grouting at end of each work day. Obtain written acceptance from Project Manager of inside joints before proceeding with next day's pipe laying operation. During inspection, insure no delamination of joint mortar has occurred by striking joint mortar lining with rubber mallet. Remove and replace delaminated mortar lining.
7. Butterfly Valve Rehabilitation:
 - a. Where directed, remove and replace actuators on existing butterfly valves.
 - 1) Prior to purchasing new actuator, identify markings on existing actuator (make, model, serial number, etc.). Submit new actuator of similar or larger size, compatible with existing valve.
 - 2) Procure and install new actuator in accordance with City of Houston Specification 02522 – Butterfly Valves.
 - b. Where directed, field replace the rubber seat which may be located around the perimeter of the disk edge, or around the inner circumference of the valve body, depending on the original manufacturer's design.
 - c. Verify valve and valve seat type and check for availability of replacement seat parts prior to removing existing seat.
 - 1) New seat to be Buna-N or approved equal manufactured to specifications of original product.
 - 2) Anticipate removal and re-installation of stainless steel retainer glands and bolts.
 - d. Where directed, remove any existing coatings on the valve disk and around the inner circumference of the valve body which have become loose or disbanded. In those areas, expose the bare metallic surface. Intact coatings may remain in place, but must be thoroughly cleaned and prepared (roughened) for recoating.
 - 1) Coat with 2 part epoxy coating certified for potable water condition in accordance with City of Houston Specification 02522.
8. A specialty electromagnetic inspection subcontractor (the specialty subcontractor) will be required to provide specialty inspection services to identify broken

prestressing wires. The specialty contractor shall also attempt to determine if joints along the pipe are electrically continuous (bonded).

- a. The specialty contractor shall have at least 10 years of experience and with pipe of this diameter and type (Embedded Cylinder PCCP).
- b. Contractor shall provide schedule coordination and any necessary traffic control and confined space safety support required by their specialty subcontractor.

3.03 DISINFECTION OF WATER LINES

- A. Following the assessment and all repairs, remove construction debris or foreign material and thoroughly broom clean and flush piping systems. Provide equipment and labor for cleaning. City will inspect water line for cleanliness prior to reinstalling access manway flanges and filling.
- B. Provide support during filling, disinfection and flushing by providing reasonable labor, blow-off piping at all new manway flanges, and traffic control where needed.
- C. Conform to requirements of Section 02514 - Disinfection of Water Lines.

3.04 FIELD HYDROSTATIC TESTS

- A. Unless otherwise specified, no hydrostatic test shall be performed on existing pipe. Wall welds should be tested by an independent weld tester, and when possible, repaired line will be left exposed during refiling to visually inspect for leaks.

END OF SECTION

VACUUM RELIEF VALVES

Section 02524 S

AIR RELEASE AND VACUUM RELIEF VALVES

The following supplement modifies Specification Section 02524 – Air Release and Vacuum Relief Valves. Where a portion of the Specification is modified or deleted by this Supplementary Specification, the unaltered portions of the Specification shall remain in effect.

1.02 MEASUREMENT AND PAYMENT:

Insert the following paragraphs:

5. Unit Price Work Items are also included separately for removing and replacing air valves in accordance with Specification Section 02524 and includes:
 - a. Air valves – Apco Models 145C, 1503C, 1504C or approved equal.
 - b. Provide #316 stainless steel Sch. 80 piping with flanged connection between the air valve and existing gate valve.
 - c. All piping and fittings necessary to connect new air valve to existing vent piping.

6. Unit Price Work Items are also included for new air valves on new or existing pipe with manhole in accordance with Specification Section 02524 and includes:
 - a. Air valves – Apco Models 145C, 1503C, 1504C or approved equal.
 - b. All piping, bends, unions, fittings, supports, flanged connections, accessories, etc. Use Sch. 80 galv. Steel for piping on the “dry” side of an air valve.
 - c. Provide #316 stainless steel Sch. 80 piping with flanged connection between the air valve and gate valve.
 - d. Manhole wall penetrations per Specification Section 02082.
 - e. Bollards – Add new bollards for a total of three (3) bollards in a triangular pattern (3’ centers) set in Class B concrete (18” dia. x 3’ deep) filled with concrete and crowned. Extend 6” standard strength galvanized steel pipe bollards 3’ above grade.
 - f. Two (2) galvanized steel straps (1-1/2” wide x 3/16” thick) with 5/8” dia. stainless steel nuts, bolts and washers.
 - g. Stainless steel (#316) insect screen (#16 mesh) with insulating gasket including flanges and hardware with 180° flanged vent pipe return, or approved vent cap.
 - h. Paint bollards and vent piping Forest Green. Submit color sample for approval.
 - i. Two (2) 2” wide reflectorized tape strips on each bollard.

VACUUM RELIEF VALVES

END OF SUPPLEMENT

Approved by:

Arthur Morris, P.E.
Managing Engineer
Water Engineering Section
Engineering and Construction Division

Date

Section 02530

**EXTERNAL POST-TENSIONING REPAIR
OF LARGE DIAMETER PIPELINES**

PART 1 GENERAL

1.01 SUMMARY

- A. Installation of external post-tensioning tendons.
- B. Specification identifies requirements for materials, construction and contractor experience.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Price Work Items are included for each installation of external post-tension system for one (1) pipe section on an existing 48-inch prestressed concrete cylinder pipe (PCCP).

- 1. Pipe Section MK #243 is to be externally reinforced. Refer to original lay schedule, 91-56L, for more information (see Appendix A at the end of project manual).

- B. Furnish labor, all materials, tools, equipment, transportation, storage, supervision, and inspection required for the design, supply, and installation of External Post-Tensioning Tendons (EPT) systems to the external surface of PCCP including protective coatings, to rehabilitate the PCCP as directed by Project Manager.
- C. PCCP preparation and repair as well as clean-up after the completion of work shall be performed by the Contractor.
- D. The work related to the installation of EPT shall be coordinated with other trades working in the area.
- E. The EPT system shall be installed by a Contractor certified by the product manufacturer by means of written verification.

1.03 REFERENCES

- A. Design and installation of the EPT system must comply with pertinent provisions of the following codes and standards. These written specifications take precedence over incorporated references. The latest revision of the code or standard in effect at the time of execution of the contract shall be used.

American Concrete Institute (ACI)

- ACI 224.1R: Causes, Evaluation, and Repair of Cracks in Concrete Structures.
- ACI 350: Building Code Requirements for Environmental Engineering Concrete Structures.
- ACI 546R: Concrete Repair Guide.

American Society for Testing and Materials (ASTM)

- ASTM A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- ASTM A416: Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
- ASTM C157: Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete

American Water Works Association (AWWA)

- AWWA C301: Standard for Prestressed-Concrete Pressure Pipe, Steel-Cylinder Type.
- AWWA C304: Standard for Design of Prestressed-Concrete Cylinder Pipe.
- AWWA M9: Manual of Water Supply Practices, Concrete Pressure Pipe

International Concrete Repair Institute (ICRI)

- ICRI 03730: Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.
- ICRI 03733: Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces.

Post-Tensioning Institute (PTI)

Post Tensioning Manual

- PTI M10.2: Specification for Unbonded Single Strand Tendons
- PTI M55.1: Specification for Grouting of Post-Tensioned Structures.

1.04 DATA PROVIDED BY ENGINEER

- A. The Engineer shall provide all available relevant documents including specifications sheets, lay schedules, plan and profile drawings, and if available, reports of pipeline condition assessment and past performance, photographs of repair pipes, geotechnical reports, and all other relevant data and reports.
- B. The Engineer shall provide all information listed in Section 2.02.A.1 of this specification for each segment of pipe to be repaired with EPT.

1.05 SUBMITTALS

- A. All submittals shall be promptly submitted to the Engineer for approval in accordance with “Submittal Procedures” Section and instructions provided in the specification.
- B. External Post-Tensioning Product Data:
 - 1. Include:
 - a. Manufacturer’s product data sheet indicating physical, mechanical, and chemical characteristics of all materials used in the EPT system.
 - b. Manufacturer’s Material Safety Data Sheets (MSDS) for all materials to be used.
 - c. Properties of the composite materials as determined by independent laboratory testing.
 - d. Manufacturer’s certification that the materials and process used meets OSHA, EPA, and local ordinances for health and safety, including VOC compliance.
 - 2. Sequencing of stressing operations shall be submitted and justified in calculations.
 - 3. Written verification from the manufacturer that the installer has received the required certifications and training.
 - 4. Written verification from the manufacturer that the anchor blocks and wedges work well with specified strand types.
- C. Working Drawings, Calculations, and Methods Statements:
 - 1. Working drawings should provide the following:
 - a. Type of system.
 - b. Materials.
 - c. Tendons: type, number, and spacing.
 - d. Individual tendon stressing calculation data defining the theoretical values of stressing force and elongations.
 - e. Anchor Blocks: type, number, spacing, and locations.

- f. Repair procedures and details for damaged mortar coating.
 - g. Repair procedures for damaged tendon sheathing.
 - h. Detail of proposed method of anchoring tendons in anchor blocks.
2. The working drawings and calculations shall be prepared by an EPT Design Engineer who satisfies the requirements of Section 1.04.E of this specification for EPT Design Engineer Qualifications and shall be marked “Preliminary Set, Not for Construction.” This set of drawings and calculations shall serve as the technical package for verification of the Contractor’s compliance with the specification. The Engineer shall review and provide comments on the drawings and calculations from the selected Contractor which shall be incorporated into the “For Construction” drawings described in the Construction Submittals Section.
 3. Manufacturer’s written installation procedures, maintenance instructions, and general recommendations regarding the overall system and each material to be used including:
 - a. Method for preparing surfaces to install EPT system.
 - b. Method, equipment, and procedures to be used to install EPT system.
 - c. Method and drawings detailing installation of EPT system.

D. Construction

1. Submit a quality control report describing the inspection of the installation. The submittal shall include the following:
 - a. Names of key personnel (foreman, head supervisor and top three EPT installation technicians) scheduled to perform the work.
 - b. Name of personnel responsible for quality assurance.
 - c. Surface evaluation procedure.
 - d. Installation procedures of all components including strands, wire for electric continuity of strands, and anchor blocks.
 - e. Methods for repairing defective tendon sheathing.
 - f. Contingency plan to meet specified requirements in the event of an interruption to the EPT installation.
 - g. Calibration charts for each stressing unit sent to the job site. Calibration of hydraulic rams, pumps, and gauges shall be performed against independent laboratory calibrated load cells prior to shipping stressing equipment.
2. Prepare and submit a detailed schedule describing work to be accomplished prior to the start of the shutdown and work to be accomplished during each shift during the shutdown. Detail daily activities and manpower used at each site. If the Engineer deems any schedule to be inadequate to secure the completion of work in the time submittal, correct and re-submit schedules to change the order of prosecution of work to ensure proper and timely execution.

3. Contractor shall submit stamped and signed structural calculations and drawings by a Civil or Structural Engineer licensed in the State of Texas. Refer to Section 1.04.E.3 of this specification for Design Engineer Qualifications. The stamped drawings and calculations submitted shall be marked “For Construction” and shall have incorporated the Engineer’s comments from review of the working drawings and calculations submitted with the final submission.
- E. Technical Experience Requirements – External Post-Tensioning (EPT) Tendon Repair on Large Diameter Prestressed Concrete Cylinder Pipe (PCCP) Water Mains.
1. The Installer’s personnel responsible for project oversight has successfully completed construction of at least three (3) EPT repair projects on PCCP water mains or other cylindrical concrete structures in the past 3 years in the United States.
 2. At least one of these projects must have been completed in the past 2 years.
 3. The Designer of the EPT repair project must have completed 5 repair designs on large diameter (greater than 48-inch) pressurized PCCP pipelines or other cylindrical structures in the United States within the last 3 years.
 4. The Installer must employ personnel that have completed a minimum of 2 EPT repair projects in the United States within the last 10 years.
 5. The Installer must have completed 20 repairs on large diameter (greater than 24-inch) pressurized PCCP pipelines or similar cylindrical concrete structures in the United States within the last 5 years.
- F. All materials proposed in the EPT system shall be compatible. No substitution shall be allowed without the prior written authorization of the Engineer.
- G. Record Keeping:
1. Maintain and submit daily logs of tensioning operations. Submit to Engineer no later than the beginning of the following work day.
- H. Project Close- Out:
1. Submit a completed QA/QC report describing the inspection of the installation in which documents all inspection steps described in Section 4 of this specification.
 2. Provide a warranty for the completed work in accordance with Document 00700 – General Conditions.

1.06 INTRODUCTION

- A. Due to the sensitive nature of the application of EPT systems, it is paramount that a comprehensive QA/QC be devised and implemented for the successful execution of a project. The Contractor shall be responsible for the quality control of all materials and processes in the project. The QA/QC program must be approved by the Engineer. The QA/QC plan shall include specific procedures for personnel safety, tracking and inspection of all EPT components prior to installation, inspection of all prepared surfaces prior to EPT installation, inspection of the work progress to ensure conformity to specifications, inspection of all completed work, repair of any defective work, and clean up.

1.07 FIELD QUALITY CONTROL

- A. Provide a trained field supervisor or an EPT Design Engineer's representative to observe all aspects of onsite preparation and system installation.
- B. Prior to installation of protective shotcrete coating, a visual inspection shall be performed to inspect for evidence of any damaged tendon sheathing.

1.08 MATERIALS INSPECTION

- A. The packaging list and all delivered materials must be inspected for conformity to the construction documents. Any material that does not meet the requirements of the construction documents shall be rejected and replaced with the correct material.

1.09 DAILY INSPECTION

- A. Daily inspection should be performed to record date and time of repair; ambient and concrete surface temperatures; general weather conditions; location and size of any damaged concrete; observations of the progress of tendon installation; and the general progress of the work.

1.10 TENDON ORIENTATION INSPECTION

- A. Tendon orientation and spacing will be visually examined for conformity to the contract documents. Non-conforming areas will be removed and repaired at the Contractor's expense.

PART 2 PRODUCTS

2.01 EXTERNAL POST-TENSIONING TENDON SYSTEM

- A. The EPT system shall consist of either:

1. For ducted non grouted system: Greased and sheathed unbonded steel strand inserted into a plastic duct. The entire system, including the connections between duct and anchorage, shall be watertight. Anchorages shall be designed to attain watertight encapsulation of prestressing steel and shall have demonstrated the ability to remain watertight when subject to a uniform hydrostatic pressure of 10 psi (68.9 kPa) for a period of 24 hours, per ACI 350-06 section 18.16.3.
 2. For ducted grouted system: Greased and sheathed unbonded steel strand inserted into a plastic duct, the annular space of which is grouted with cement based grout prior to tensioning. Grout, shall be pre-bagged, non-shrink, thixotropic, non-bleed grout meeting 0% bleed during Schupack bleed test at 50 psi per PTI M55.1, Appendix C. The entire system, including the connections between duct and anchorage, shall be watertight. Anchorages shall be designed to attain watertight encapsulation of prestressing steel and shall have demonstrated the ability to remain watertight when subject to a uniform hydrostatic pressure of 10 psi (68.9 kPa) for a period of 24 hours, per ACI 350-06 section 18.16.3. 0.
 3. For non-ducted system with shotcrete: Greased and sheathed steel cable strands applied directly to the pipe using one anchor block per wrap around the pipe circumference. The strands and anchor blocks shall be encased in fiber-reinforced shotcrete with a minimum cover of 3 inches over the tendons and anchor blocks. The shotcrete shall include minimum reinforcing steel equal to 0.60-in² per foot in both directions. Shotcrete material shall conform to ASTM C157 (Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete) with a maximum shrinkage of 0.08%.
- B. Use materials for the EPT system from a single manufacturer, if possible, and ensure the compatibility of the products. Obtain written permission from ENGINEER to use materials from different manufacturers that are certified compatible by the different manufacturers.
- C. Products shall be produced by a Post-Tensioning Institute (PTI) certified plant and have the following properties:
1. Strand shall be low relaxation, seven wire strand, having a guaranteed minimum ultimate tensile strength of 270,000 psi, per ASTM Designation A 416, low relaxation. The sheathing for unbonded tendons shall be manufactured from high-density polyethylene (HDPE) and shall be produced by a seamless extrusion process over corrosion preventative grease that leaves no air pockets and has at least a 60 mil thickness with no negative tolerance.
 2. Ducts, where applicable, shall consist of HDPE/HDPP (High Density Polyethylene/High Density Polypropylene) duct. The duct shall be positively connected to the anchorage with watertight, corrosion proof, connections.

3. Anchor blocks shall anchor one strand loop, four strand loops (two strands, each wrapped twice around the pipe), or two strand loops (each wrapped once around the pipe). The post-tensioning manufacturer shall provide anchor blocks and wedges compatible with the provided strand. The anchor block shall have permanent caps and sleeves for strands at anchor blocks. Corrosion protection of the anchor blocks shall be provided by either hot dipped galvanizing according to ASTM A123 (3.50 mil minimum) or other acceptable corrosion protective coating or a minimum of 3-inch cover of fiber-reinforced shotcrete.
4. Corrosion preventive grease for strand repairs shall be lithium-based, containing corrosion inhibitors, wetting agents, and less than fifty parts per million of chlorides, sulfides or nitrates.
5. Tape for strand repairs shall be adhesive coated, polyvinyl chloride, 9 mil minimum tape thickness, and 2-inch minimum width.
6. Where electric continuity is provided, wire shall be No. 8 insulated AWG wire with ¼ in. wire ring terminal and accessories as shown on the drawings and welded studs shall be used for attachment of continuity wire to pipe joint rings.
7. Where anchor blocks anchor one strand, two galvanized metal sheets shall be provided under each anchor block with lubricating grease in between.

2.02 DESIGN REQUIREMENTS

A. Loadings:

1. The EPT System shall be designed to resist loads from earth pressure, live loads, internal pressures, and all other loads specified herein. The design shall be based on the maximum of the forces resulting from different load combinations.
 - a. External Vertical Soil Pressure due to a Soil Height of 10 Feet.
 - b. Groundwater of up to Top of Soil.
 - c. Surface Transient Loads Assumed to be HS20 Vehicular Loads unless specified otherwise by the Engineer.
 - d. Internal Working Pressure of 100 psi.
 - e. Internal Pressure with Water Hammer of 150 psi.
 - f. Vacuum Pressure of up to -10 psi.

B. Design Requirements:

1. The Contractor shall provide detailed design calculations to verify that the repaired pipes shall sustain all internal and external specified loads from water pressure, earth pressure, temporary excavation below pipe, plus the old and new PT forces.

2. Original prestress and outer mortar coating shall not be considered as contributing to the capacity and strength of pipe. Assume original prestress is lost. For compression checks, however, the original prestress must be included.
3. All relevant load combinations and calculations per AWWA C301 and C304 shall be considered.
4. New external post-tensioning must provide the minimum ultimate strength capacity and serviceability limits for a pre-cracked repaired PCCP following AWWA C304 design limit states.
5. Short term and long term forces shall be calculated.
6. Design life for system shall be a minimum of 50 years.
7. Calculations shall include all friction losses and relaxation of the cables as well as seating losses of the anchor wedges.

PART 3 EXECUTION

3.01 GENERAL

- A. The integrity and quality of the finished EPT system depends on a careful initial planning and evaluation of the project. All construction specifications, material storage, and handling as well as installation steps must be carefully reviewed by all those involved in the project and adhered to. The following sections describe various steps necessary for successful completion of the projects constructed.

3.02 INITIAL PLANNING

- A. Due to the complexity of placing a large diameter transmission pipeline out of service, it is recommended that careful planning for executing different stages of the projects constructed with the Master Agreement is put in place at the start of a project to assure timely and efficient execution. Several important points to consider include, but are not limited to the following:
 1. Schedule: Plan installation dates and times.
 2. Equipment: Provide all tools and equipment necessary for the particular project.
 3. Materials: Provide sufficient lead time and order all materials from manufacturer to be ready and onsite before the start of the work.
 4. Work Force: Determine size, skill level, and time frame for the work force.

5. Onsite Assistance: Work with manufacturer to determine if an onsite representative of manufacturer is required.

3.03 EXAMINATION

- A. With Engineer and installer present, examine substrates, areas, and conditions under which EPT system will be applied for compliance with requirements. Correct all unsatisfactory conditions before proceeding with installation. Notify Engineer immediately in writing of anticipated problems using EPT system over substrate.
- B. Examine the existing conditions to identify potential obstructions and constraints, joint locations, verify dimensions and geometry, and map all visible voids and cracks in the length of pipeline being rehabilitated. Submit photos or a drawing showing pipe condition prior to repairs.

3.04 PREPARATION

The effectiveness, integrity, and performance of all EPT systems depend on the preparation and soundness of the substrate.

- A. Removal of Damaged and Unsound Mortar
 1. Environmental effects and corrosion of the prestressing wire can cause damage to mortar coating of PCCP. Any such mortar coating area that is determined by the Engineer or other properly trained personnel to be damaged and unsound, must be removed and repaired, as necessary to provide even surface for PT tendons before EPT can be applied. Defects and sharp edges in the mortar substrate can compromise the strength and durability of the EPT. Careful attention must be paid when removing defective mortar as not to damage the surrounding areas. Remove loose coating and prestressing wire from the concrete core in a full circumferential zone, if necessary. Do not remove mortar coating if it is sound or is only cracked but well adhered to the core.
- B. Repair of Mortar Surface
 1. When mortar coating is damaged, area shall be removed and patched with non-shrink repair mortar similar in compressive strength to that of mortar coat to match that of existing PCCP.
- C. Water Pressure during Pipe Rehabilitation
 1. When pipe sections are repaired without dewatering, the internal pressure of the pipe will be controlled to a safe pressure determined by analysis and defined as the repair threshold pressure which will be maintained by the Engineer.
- D. Excavation of Pipeline

1. Once the repair threshold pressure has been established, excavation can commence. The central support of the pipe bedding shall remain in place if required.
2. The excavation is done in two steps:
 - a. Excavate the pipe to a depth of 1/2 (half) of the pipe. The Engineer and Contractor shall then examine the pipe condition and determine the repair threshold pressure of the pipe is adequate before proceeding with the excavation.
 - b. Excavate the pipe to a depth of approximately 1 foot below the bottom of the pipe. The pipe length shall be temporarily supported as required per the EPT Design Engineer.

3.05 APPLICATION OF EPT SYSTEM

The application of the EPT system shall be performed in accordance with the manufacturer's instructions.

- A. For ducted non-grouted system:
 1. Anchor locations shall be marked and placed on the pipe, fully ready to receive strand and duct. Place the neoprene sheets at the locations of the new anchor blocks.
 2. Tendon assemblies shall be prefabricated including- duct cut to length and secondary duct sections slid over the primary duct. Coated strands shall be precut to length (including stressing tails) and placed in primary duct. Dead ends will be set using a hand setting tool. All secondary ducts and mechanical fittings will be installed on the assembly
 3. Tendon assemblies will be installed on the pipe per the prescribed stressing sequence.
 4. Stressing operations shall be conducted in three separate operations. Both of the stressing tails at each anchorage shall be stressed simultaneously. First stressing to approximately 5% for fitting/alignment purpose. Stress to 50% and ensure alignment of anchorage blocks are within prescribe tolerances. Maximum final stressing force is 75% GUTS (Guaranteed Ultimate Tensile Strength). All strand elongations and stressing force shall be recorded. Elongations shall be analyzed prior to cutting tails and sealing of anchors.
 5. Inject anchor block with grease if necessary with a predetermined amount of grease to ensure complete filling of the anchorage block. Install caps and sleeves over strand such that they are in tight contact with anchor blocks. Fill

caps with sleeves with corrosion inhibiting grease, per Section 2.01.C of this specification.

6. Backfilling operation can begin upon written approval of stressing log verification by the Engineer.

B. For the ducted grouted system:

1. Anchor locations shall be marked and placed on the pipe, fully ready to receive strand and duct. Duct shall be cut to length and placed on the ground prior to fitting with strand. Coated strands shall be precut to length (including stressing tails) and placed in outer duct prior to placing around pipe.
2. All grouting operations shall be in accordance with PTI M55.1. Mixing equipment shall be colloidal mixer with variable pressure and flow capabilities. Prior to grouting, a visual inspection of all connections shall be performed. Any incomplete connections shall be completed prior to grouting.
3. Stressing operations shall not begin before 12 hours after the last duct has been grouted in section of pipe being strengthened AND a minimum compressive strength of 1500 psi. Stressing shall not begin until both conditions are met. All 4 stressing tails at each anchorage shall be stressed simultaneously. Maximum initial stressing force is 75% GUTS (Guaranteed Ultimate Tensile Strength). All strand elongations and stressing force shall be recorded. Elongations shall be analyzed prior to cutting tails and sealing of anchors.
4. Below-pipe compaction operation shall laterally compact the backfill directly below the pipe with vertical steel panels, vibrators and horizontal prestressing. The maximum allowable lateral pressure applied to the backfill by vertical panels shall be calculated by Contractor on a pipe by pipe basis. Results shall be summarized and submitted to Engineer. Alternative methods such as flowable backfill or lean concrete are subject to approval by PT Contractor and Engineer. Backfill stiffness shall be chosen so that it does not create hard points under pipe.

C. For non-ducted system with shotcrete

1. Stagger strand installation along the pipe length by installing every other strand before installing intermediate strands. Do not post-tension adjacent strands in sequence one after another. Stagger installation of anchor blocks around pipe circumference, as shown on the drawings.
2. Cut back the strand plastic sheath on each strand so that it can be placed approximately 1-inch into the anchor block. Trim excess plastic sheath off of the strand. No strand should be left exposed outside the anchor block.

3. Place two galvanized metal sheets with lubricating grease between sheets under anchor block. Do not use too much grease such that it oozes out onto pipe or anchor block surfaces. Remove all grease from exposed surfaces.
4. Strand Stressing: Stress strands to 80% of the minimum breaking load. Pause for 1 minute to allow for equalization of forces. Bring the pressure to the desired level again and release the pressure in the jack slowly. Check to see that the wedge tops are no more than 1/8-inch apart. If they are more than 1/8-inch apart, wedge grip effectiveness may be reduced. Review stressing technique and restress to better seat the wedges while taking complete safety precautions. During stressing, should the anchor block be moved too far out of line with the strand, repeat the stressing operation on the other strand end to move the anchor block back to the center position. If the single stroke stressing does not develop sufficient load in the strand according to the specifications, repeat the stressing procedure to bring the strand up to the desired load. Maintain the record of the post-tensioning strand stressing chart for the EPT Design Engineer's review.
5. Inject anchor block with grease until it comes out from strand holes. Install caps and sleeves over strand such that they are in tight contact with anchor blocks. Fill caps with sleeves with corrosion inhibiting grease, per Section 2.01.C of this specification.
6. Install electrical continuity wire (if required) as shown on the drawings. Weld studs to the joint ring, taking care to not penetrate through or otherwise damage steel cylinder or joint ring, and verify proper installation by performing a bend test. Pack the hole after testing of stud with Sika Monotop 615 or Sikatop 123 Plus.
7. Shotcrete placement: Keep pipe surface moist for a minimum of 2 hours before placement of shotcrete. At the time of shotcrete placement, the concrete surface is to be in a saturated surface dry condition. Place shotcrete or concrete cradle under post-tensioned pipe section. Do not place cradle under adjacent pipe that is not post-tensioned. The shotcrete shall include minimum reinforcing steel equal to 0.60 in² per foot in both directions. Shotcrete material shall conform to ASTM C157 (Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete) with a maximum shrinkage of 0.08%. Apply shotcrete coating. Adjust thickness to obtain a minimum cover of 3-inches over tendons and anchor blocks. Immediately before applying shotcrete, apply cement slurry (94-lb cement to 8 gallons of water) to exposed steel anchor blocks. Remove shotcrete overspray from adjacent pipe that is not post-tensioned. When removing shotcrete from adjacent pipe, do not damage shotcrete on post-tensioned pipe. Cure shotcrete coating by keeping it moist for 7 days. Either cover with burlap and plastic membrane, or backfill and keep soil moist. Maintain placed shotcrete temperature at min. 55°F for a period of 72 hours after placing, until backfilling, or for as long a time to assure proper curing

8. Backfilling can begin after the required curing period following the placement of the shotcrete coating.

END OF SECTION

2. Three moisture-density relationship tests prepared using the material qualified by the tests of Paragraph 1.04 B.1. Test blends of fine aggregate from crushed concrete and bank run sand at ratio to be used for mix design testing.
 3. Mix design report to meet design requirements of Paragraph 2.01. Include compressive strength tests after 48-hours and 7 days curing.
- C. Submit source of cement-sand material.

PART 2 P R O D U C T S

1 MATERIALS

- A. Conform to requirements of Section 02321 - Cement Stabilized Sand.

2 MIXING MATERIALS

- A. Conform to requirements of Section 02321 - Cement Stabilized Sand.

PART 3 E X E C U T I O N

1 FIELD QUALITY CONTROL

- A. Conform to requirements of Section 02321 -Cement Stabilized Sand for performance, testing and adjustment for deficient strength.
- B. Material not placed, compacted and finished within 4 hours after mixing shall be rejected.

2 PREPARATION OF SUBGRADE

- A. After excavation and/or fill is made to subgrade lines, remove soft or undesirable material and replace with material as specified under Section 02317 - Excavation and Backfill for Utilities. Grade and shape subgrade required to construct cement-stabilized sand base in conformance with lines, grades, thickness and typical cross section shown on Drawings.
- B. Compact subgrade material as specified in Section 02317 - Excavation and Backfill for Utilities.

3 PLACING

- A. Do not exceed percentage of moisture in soil subgrade at time of cement-stabilized sand base placement that permits uniform and intimate cement sand curing during placement operations. Do not exceed specified optimum moisture content for surrounding soil.
- B. Place cement-stabilized base in uniform layers to produce depth indicated on Drawings. Place material in a single layer for depth of 6 inches or less. Place no single layer thicker than 6 inches or less than 3 inches for depth greater than 6 inches.
- C. Provide material on dry side of optimum moisture content during compaction but sufficient for hydration.
- D. Make vertical construction joints between new material and material placed for more than 4 hours. Form plane of joint by a header removed immediately prior to placing new base, or cut base placed first to a vertical edge immediately prior to placing new base.
- E. Do not place base when air temperature is below 40°F and falling. Place when temperature is above 35°F and rising. Take temperature in shade and away from artificial heat.

4 COMPACTION

- A. Roll loose mixture with tamping rollers in addition to plate compactors or tandem rollers. Compact with mechanical hand tampers in places inaccessible to roller
- B. Compact to 95 percent ASTM D558, unless otherwise specified.
- C. Reconstruct sections when moisture content of uncompacted material exceeds amount required for proper hydration of cement.

5 FINISHING

- A. Finish surface to grade by blading and seal with pneumatic or flat wheel rollers after final course is compacted. Other means providing a dense, uniform surface and avoiding compaction planes are permitted.
- B. Correct any deviation from plan surface in excess of 1/4 inch in cross section and in length of 16 feet measured longitudinally prior to paving. Correct irregularities or weak spots by removing full depth of affected areas. Replace with suitable material as required. Reshape and compact.

- C. Maintain moisture content of surface material at ± 2 percent of optimum moisture. Proceed with surface compaction and finishing to produce a smooth, closely knit surface, free of cracks, ridges or loose material. Conform to crown, grade and line shown on Drawings, or as required to ensure proper drainage of pavement.

6 CURING

- A. Protect finished surface against rapid drying by maintaining a moist condition. Sprinkle for not less than 3 days or until surface or pavement is placed.

7 TRAFFIC AND MAINTENANCE

- A. Completed section of cement-stabilized sand base may be opened to local traffic and construction equipment after curing period, provided base material has hardened sufficiently to prevent marring or distorting surface by equipment or traffic.
- B. Maintain cement-stabilized base in good condition until pavement replacement has been completed and accepted. Immediately repair defects, as often as needed to keep area intact. Repair cement-stabilized base to full depth by replacement. Do not repair by adding a thin surface layer to damaged part.

8 ADJUSTMENT FOR DEFICIENT BASE THICKNESS AND STRENGTH

- A. Construct base to thickness and typical section shown on Drawings. Where base does not conform:
 - 1. City may core drill base prior to final acceptance. Cores will be drilled full thickness of section. At least three core thicknesses will be averaged to determine base thickness.
 - 2. A base within $\frac{1}{2}$ inch of required thickness will be considered as satisfactory.
 - 3. A base thickness between $\frac{1}{2}$ inch less and $1\frac{1}{2}$ inches less than required thickness will be considered deficient. Adjusted unit price will be used in payment.
 - a. Adjusted unit price will bear same ratio to unit price as square of actual average thickness of base bears to square of thickness shown.
 - b. Length of area of such deficient thickness will be determined by additional cores taken at 10-foot

intervals in both directions until cores are obtained which are at least that required thickness less $\frac{1}{2}$ inch.

- c. Width of deficiency will be entire width of base as placed in one operation within length as determined above.
 4. No payment will be made for base found more than $1\frac{1}{2}$ inches deficient. Length of unsatisfactory area will be determined by additional cores at 10-foot intervals in both directions until cores are obtained which are required thickness less $\frac{1}{2}$ inch. Width will be entire base as placed in one operation within length determined as above. Remove and replace such base with base of specified thickness.
 5. No additional payment over unit price will be made for thickness exceeding that required.
 6. Contractor responsible for cost of cores taken to define limits of deficient base thickness.
- B. Refer to Section 02321 - Cement Stabilized Sand, paragraph 3.03 for payment adjustment for deficient strength.

END OF SECTION

Section 02821

CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fence framework, fabric, and accessories.
- B. Manual gates and related hardware.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. Payment for removing and replacing chain link fences and gates under this Section and as shown on Drawings will be by linear foot for all heights.
 - 2. Refer to Section 01270 - Measurement and Payment.
- B. Stipulated Price (Lump Sum). If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.03 REFERENCES

- A. ANSI/ASTM A 123 - Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
- B. ANSI/ASTM F 567 - Installation of Chain-Link Fence.
- C. ASTM A 116 - Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric.
- D. ASTM A 120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless, for Ordinary Uses.
- E. ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- F. ASTM A 392 - Zinc-Coated Steel Chain-Link Fence Fabric.
- G. ASTM A 428 - Weight of Coating on Aluminum-Coated Iron or Steel Articles.
- H. ASTM C 94 - Ready-mixed Concrete.
- I. ASTM F 573 - Residential Zinc-Coated Steel Chain Link Fence Fabric.

J. ASTM F 668 - Poly (Vinyl Chloride) (PVC) Coated Steel Chain Link Fence Fabric.

K. Chain Link Fence Manufacturers Institute (CLFMI) - Product Manual.

L. FS RR-F-191 - Fencing, Wire and Post Metal (and Gates, Chain Link Fence Fabric, and Accessories).

1.04 SYSTEM DESCRIPTION

A. Remove and replace chain link fabric and gate with new materials as required in this Section, match existing dimensions. Existing frame to remain in place.

1.05 SUBMITTALS

A. Submit following Section 01330 - Submittal Procedures.

B. Shop Drawings: Indicate plan layout, spacing of components, hardware anchorage, and schedule of components.

C. Product Data: Provide data on fabric, accessories, fittings, and hardware that indicates items match or exceed the quality of existing items.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years experience.

1.07 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings. Match dimensions of existing fence frame.

PART 2 PRODUCTS

2.01 GALVANIZED FENCING

A. Fence fabric shall be No. 9 steel wire, hot galvanized after weaving, to match or exceed existing fence fabric.

B. Framework shall be hot-dipped galvanized with a minimum coating of 2 ounces per square foot, or one ounce per square foot plus 30 micrograms per square inch of chromate conversion coating.

C. Line posts shall conform to ASTM A 570 Grade 45 steel or ASTM A 569, cold rolled steel.

- D. End corner, angle, and pull posts shall conform to ASTM A 570 Grade 45 steel or ASTM A 569 for steel pipe.
- E. Top rails shall be 1.65 x 1.25-inch formed C-section; or 1.6-inch round ASTM A 569, 1.35 pounds per foot; or 1-5/8-inch outside diameter steel pipe, 2.27 pounds per foot. Top rails shall pass through openings provided for that purpose in post tops.
- F. Fabric ties shall be hog rings, galvanized steel wire not less than 9 gauge with a zinc coating of not less than 1.2 ounces per square foot.
- G. Bolts and nuts shall be in conformance with ASTM A 307 and shall be galvanized in accordance with AASHTO M 232.
- H. Install horizontal braces fabricated of 1-5/8-inch, 2.27-pound copper bearing steel pipe at all corner, gate, and end posts.
- I. Gates shall be either swing or slide, as shown on the Drawings. Swing gates shall be hinged to swing 90 degrees or 180 degrees from closed to open. Slide gates shall be roller type with no vertical obstructions. All gate leaves shall have intermediate members and diagonal stress rods as required for rigid construction and shall be free from sag or twist. All gates shall be fitted with vertical extension arms or shall have frame end number extended to carry barbed wire. Gate posts for gates shall be 4-inch, 9.1-pound pipe. Gate frames shall be made of 2-inch outside diameter, castings. Fabric shall be the same as for the fence. Gates shall have malleable iron ball and socket hinges, catches, and stops.
- J. Provide padlocks with 2 keys each for each gate. Locks for multiple gates at a single location will be keyed alike. Posts for single gates shall be the same as end posts.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install chain link fence in accordance with the directions of the manufacturer and these Specifications.
- B. Install fence posts at not more than 10-foot centers and at least 36 inches into the ground in a Class B concrete base. Allow concrete to cure for at least 7 days before erecting remainder of fence. Fasten fabric to line posts with wire ties spaced about 14 inches apart and to top rail spaced about 24 inches apart.
- C. Use standard chain link fence stretching equipment to stretch the fabric before tying it to the rails and posts. Repeat the stretching and tying operations every 100 feet or less.
- D. Erect gates so they swing or slide in the appropriate direction. Provide gate stops. Secure hardware, adjust, and leave in perfect working order. Adjust hinges and diagonal bracing so gates will hang level. Adjust rollers and guides of sliding gates so gates are level.

- E. At small natural or drainage ditches where it is not practical for fence to conform to contour of the ground, span the opening below the fence with wire fastened to stakes of required length. The finished fence shall be plumb, taut, true to line and ground contour. When directed, stake down the chain link fence at several points between posts.

- F. Where new fence joins an existing fence, set a corner post and brace post at the junction and brace as directed. If the connection is made at other than the corner of the new fence the last span of the old fence shall contain a brace.

END OF SECTION

SECTION 13400

INSTRUMENTATION AND CONTROL GENERAL PROVISIONS

PART 1 - G E N E R A L

1.01 SUMMARY

- A. Provide labor, materials, equipment, and accessories required for a complete and functional instrument and control system as required by the contract documents. The requirements outlined in this section address general hardware, software, and system services necessary to provide the specified control functions. More detailed requirements of specific functions and components are presented in other sections that follow.

1.02 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Instrumentation & Control (SCADA) per project site.

1.03 DEFINITIONS

- A. Where the word “provide” appears in these Specifications, it shall be construed to mean “furnish and install complete and ready for safe and regular use.”
- B. The definitions of terminology used in the Specifications shall be as defined in ANSI/ISA Standard S51.1 unless otherwise specified. Where terms used are not defined in ANSI/ISA 51.1 or in these Specifications, ANSI/IEEE Standard 100, ANSI/ISA S50.1 or other ISA standards shall apply.
 - 1. Signal Circuit. Any analog circuit whose principal purpose is the conveyance of information and not the conveyance of energy for the operation of an electrically powered device.
 - 2. Control Circuit. Any digital circuit whose principal purpose is the conveyance of information and not the conveyance of energy for the operation of an electrically powered device.
 - 3. Power Circuit. Any circuit whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
 - 4. Two-Wire Transmitter. A transmitter which derives its operating power supply from the signal transmission circuit and therefore requires no separate power supply connections. As used in this specification, two-

wire transmitter refers to a transmitter which provides a 4 to 20 milli-ampere current regulation of signal in a series circuit with an external 24 volt direct current driving potential and a maximum external circuit resistance of 600 ohms.

5. Electrical Isolation. Pertaining to an electrical node having no direct current path to another electrical node. As used in this specification, electrical isolation refers to a device with electrical inputs and/or outputs which are galvanically isolated from ground, the device case, the process fluid, and any separate power supply terminals, but such inputs and/or outputs are capable of being externally grounded without affecting the characteristics of the device or providing a path for circulation of ground currents. The terms "galvanic isolation," "electrical isolation", "isolation", or similar terms shall mean electrical isolation whenever used in the Specifications for electrical control and instrumentation equipment. Unless otherwise specified, electrical isolation for analog signal devices shall be in accordance with ANSI/IEEE C39.5.
6. Panel. An instrument support system which may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term "panel" in these contract documents shall be interpreted as a general term which includes flat panels, enclosures, cabinets and consoles.
7. Data Sheets. Data sheets as used in this specification shall comply with the requirements of ANSI/ISA S20.
8. Field. Locations external to a panel or piece of equipment where a field device is connected.
9. Control Room. An environmentally controlled area intended for housing control equipment, computers, control panels, etc., and intended for those parts of a control system for which operator surveillance is required on a continuing basis..
10. UPS. Uninterruptible Power Supply.
11. HMI. Human-Machine-Interface. The control system hardware and software associated with providing the visual interface between system users and the control system.
12. PLC. Programmable Logic Controller. Field installed unit which monitors and controls devices, located within the plant. The PLCs contain all logic necessary to monitor and control the system process located at the PLC location.

- 13. SCADA. Supervisory Control and Data Acquisition.
- 14. RTU. Remote Terminal Unit. Similar to a PLC, except in a more compact form.
- 15. DCS. Distributed Control System

1.04 REFERENCE STANDARDS

- A. This subsection references the latest revisions of the following standards. They are a part of Division 13 as specified and modified. In case of conflict between the requirements of this section and those of the listed standards, the requirements of this section shall prevail.

Standard	Title
ANSI/NEMA ICS 6	Enclosures for Industrial Control and Systems
API RP550	Manual on Installation of Refinery Instruments and Control Systems Part I – Process Instrumentation and Control
ANSI/ISA S5.4	Instrument Loop Diagrams
ANSI/ISA S20	Specification Forms for Process Measurement and Control Instrumentation, Primary Elements, and Control Valves
ANSI/ISA S50.1	Compatibility of Analog Signals for Electronic Industrial Process Instruments
ANSI/ISA S51.1	Process Instrumentation Terminology

1.05 WARRANTIES, MAINTENANCE, AND SUPPORT SERVICES

- A. Warranty. The manufacturer shall provide an all-inclusive two (2)-year warranty. The submittal shall provide a contract specific warranty document as detailed in the Specifications.
- B. Software Maintenance. After system software or equipment has been placed in service and tested, the Owner may request additions, modifications and deletions, at no additional cost to the Owner, to control strategies, displays, data base, and reports.

1.06 CONTRACTOR'S QUALIFICATIONS

- A. Perform all work necessary to select, furnish, configure, customize, debug, install, connect, calibrate, and place into operation all hardware and software specified within this section and in other sections as listed in Article 1.02, Related Work.
- B. Utilize a "systems integrator," regularly engaged in the design and the installation of computer systems and their associated subsystems as they are applied to the municipal water or wastewater industry. For the purposes of this specification section, a "systems integrator" shall be interpreted to mean an organization that complies with all of the following criteria:
 - 1. Employs a registered professional Control Systems Engineer or registered professional Electrical Engineer to supervise or perform the work required by this specification section.
 - 2. Employs personnel on this project who have successfully completed a manufacturer's training course on the configuration and implementation of the specific programmable controllers, computers and software proposed for this project.
 - 3. Has performed work of similar or greater complexity on at least three (3) projects within the last five (5) years and has implemented and completed at least one of these three projects with the proposed HMI software.
 - 4. Has been in similar industries performing the type of work specified in this specification section for at least five (5) continuous years.
- C. Maintain a fully equipped office/production facility with full-time employees capable of fabricating, configuring, installing, calibrating, troubleshooting, and testing the system specified herein. Qualified repair personnel shall be available and capable of reaching the facility within 24 hours.

1.07 SUBMITTALS

- A. General
 - 1. Submit to the Owner technical data and drawings for all equipment, materials, software, assemblies, and installations prior to fabrication and installation. In all instances in which submittals are required by the Specifications, do not proceed with the associated work until the submittal has been Successfully Reviewed.

2. Each submittal shall be complete, with all required information provided together at one time, and submitted in a sequence that allows the Owner to have all of the information necessary for checking and approving a particular document at the time of the submittal. Plan and make all submittals as necessary to avoid delays or conflicts in the work.
- B. Submittal Categories. Project submittals are divided into the following general categories:
1. Design Submittals
 2. System Documentation Submittals
 3. Testing Submittals
 4. Training Submittals
 5. The following paragraphs define the specific contents of each of these submittal categories. The requirements outlined for each of these submittals shall apply to all equipment and services specified in the appropriate section of the Specifications. Additional submittal requirements may be found in other sections of the Specifications.
- C. Design Submittals
1. Hardware Submittal
 - a. Product information shall include, but not be limited to: catalog cuts, data sheets, performance surveys, test reports, equipment lists, material list, diagrams, pictures, and descriptive material. The product information shall cover all items including mechanical devices, mounting components, wiring, terminal strips, connectors, accessories, and spare parts. The submittal information shall show product features, as well as all performance data and specifications.
 - b. Prior to commencement of manufacture (or shipment for stock items), submit for review product information for all equipment and material specified in the Specifications, or required to support equipment, or systems specified in the Specifications. Specific requirements for the form and content of product information submittals are included in the individual section that defines the equipment requirements.
 2. Connection Diagrams
 - a. Connection diagrams shall show the placement, labeling and wiring of components within panels, cabinets and consoles. Components shall be shown arranged in the physical layout (not necessarily to scale) as it would appear to a person servicing the equipment. Connection diagrams shall include all internal wiring of the panel; this shall include AC and DC power wiring and multi-conductor cables from PLC card to rewired termination blocks. Wires shall be shown

- as a continuous line between their termination points. Each wire label designation shall be shown. The wire label designations on each end of a single wire must be identical. All wire termination point numbers shall be shown. Each wire color shall be shown. Signal and DC circuit polarities shall be shown. All jumpers, shielding and grounding details shall be shown.
- b. Submit connection diagrams for all new panels, cabinets and consoles.
 - c. Furnish drawings on paper and in the latest AutoCAD electronic format.
3. Panel Fabrication and Layout Drawings. Submit the following panel and fabrication drawings:
- a. Panel fabrication drawings shall be drawn to scale and show the physical dimensions, materials, and construction of panels, cabinets, terminal boards, consoles, or other electrical or mechanical equipment enclosures. These drawings shall show the physical arrangement and mounting of all components in or on a panel, terminal board, cabinet, console, or enclosure, as well as the physical dimensions, and the space and mounting requirements of mechanical, electrical, control and instrumentation devices or pieces of equipment. Include ventilation requirements, locations of connections, weight, paint color, material and dry film thickness that are applicable to this design.
 - b. Panel fabrication and layout drawings shall include a bill of materials; front, back, and section views; the locations of all components to be mounted in or on the panel, cabinet, console, enclosure or assembly; drawing scale; nameplate engraving schedule; and structural materials and supports. Overall dimensions and minimum clearances shall be shown. Sufficient detail shall be included to demonstrate material choices, outward appearance, construction methods, and seismic force resistance.
 - c. Complete shop drawings shall be prepared and submitted for all panels, cabinets, and consoles which are custom fabricated or modified for this project. The Owner shall have the right to make modifications to the interior and exterior layouts of panels as part of the shop drawing review.
 - d. Furnish drawings on paper and in the latest AutoCAD electronic format.

4. Interface Cables. Submit interface cable pin-out/cable makeup diagrams. This includes all network cables, radio to PLC/RTU cables, computer to PLC cables and printer cables. Submittal shall include copies of the actual hardware documentation. All cables shall either be standard cables from the manufacturer or custom-made, without the use of gender changers, 9-25 pin converters, null modem adapters, etc.
5. Interconnection Diagrams. Submit cable interconnection diagrams. These interconnection diagrams shall include typical wiring diagrams for each type of product. Wires shall be shown as a continuous line between their termination points. Each wire label designation shall be shown. The wire label designations on each end of a single wire must be identical. All wire termination point numbers shall be shown. Each wire color shall be shown. Signal and DC circuit polarities shall be shown. All jumpers, shielding and grounding details shall be shown.
6. Installation Drawings. Submit panel installation drawings. These panel installation drawings shall show installation arrangements for all provided equipment, mounting and anchoring details, conduit entries into cabinets, and Control System electrical power supply distribution conduit and wiring. Data sheets and/or catalog cuts for mounting devices, anchors, wire and other incidental installation materials shall be included.
7. Software. Submit the following software documentation for review:
 - a. Application Software. Application software includes the software and programming developed to implement the specific requirements of the Drawings and Specifications.
 - 1) Submit functional design descriptions of the application software that implements the control strategies described in the Drawings and Specifications. These descriptions shall include field actions/interactions, control interlocks, sequencing, alarms to be generated, and operator interactions with the control strategy.
 - 2) Submit sketches of the custom graphic screens for the HMI and any field panel interfaces. This submittal shall also include a list of the symbols and color scheme for the presentation of the various data.

D. Operation and Maintenance (O&M) Manuals

1. Supply O&M manuals for all the equipment and software provided. The O&M manuals shall be developed for personnel at the level of electronic technician. The O&M manuals shall describe the detailed preventive and restorative procedures required to keep the equipment in good operating

condition. An O&M manual or a set of manuals shall be furnished for all deliverable hardware, including OEM equipment. O&M manuals for OEM equipment shall contain original printed materials, not copies, and may be provided in the manufacturer's original format. Manuals shall be provided in electronic format.

2. Instruction Manual

- a. The manual shall be written in English and illustrated in detail to the component level, including assemblies, subassemblies, and components. It shall contain a detailed analysis of each major component so that maintenance personnel can effectively service, inspect, maintain, adjust, troubleshoot, and repair the equipment.
 - b. Each manual shall include a Table of Contents, arranged in systematic order, and shall be divided into the following sections:
 - 1) Introduction. The purpose of the manual, special tools and equipment, and safety precautions.
 - 2) General Information and Specifications. A general description of the equipment item, and specifications of its major components.
 - 3) Listings. Supplier's name, address, and telephone number. Each product shall include name, address, and telephone number of subcontractor, or installer, recommended maintenance contractor, local source for replacement parts.
 - 4) Theory of Operation. The relationship of assemblies, subassemblies, components and interchangeability of components, and explanation and analysis of their functions to the smallest board replaceable components.
 - 5) Software. Listing and explanatory text for any software or firmware.
 - 6) Operation Procedures. The locations and functional descriptions of all controller indicators, or CRT displays.
 - 7) Troubleshooting. A list in tabular format of all symptoms, probable causes of malfunction or improper operation, and probable remedies to the smallest board replaceable components.
3. Preventive Maintenance Instructions. These instructions shall include all applicable visual examinations, hardware testing, and diagnostic

hardware/software routines. Instructions on how to load and use any test and diagnostic programs and any special or standard test equipment shall be an integral part of these procedures.

4. Corrective Maintenance Instructions
 - a. These instructions shall include guides for locating malfunctions down to the card-replacement level. These guides shall include adequate details for quickly and efficiently locating the cause of an equipment malfunction and shall state the probable source(s) of trouble, the symptoms, probable cause, and instructions for remedying the malfunction. These guides shall explain how to use on-line test and diagnostic programs for all devices and any special test equipment, if applicable.
 - b. The corrective maintenance instructions shall include:
 - 1) Explanations for the repair, adjustment, or replacement of all items, including printed circuit cards. Schematic diagrams of electrical, mechanical, and parts location, illustrations, photographs, and sectional views giving details of mechanical assemblies shall be provided as necessary to repair or replace equipment. Typical signal waveforms, logic levels, bit patterns, etc., shall be included. For mechanical items requiring field repair, information on tolerances, clearances, wear limits, and maximum bolt-down torques shall be supplied. Information on the loading and use of special off-line diagnostic programs, tools, and test equipment as well as any cautions or warnings which must be observed to protect personnel and equipment shall be included.
 - 2) A list of test equipment and special tools required.
 - 3) A list of all abbreviations and circuit symbols used.
 - 4) Warranties, bonds and maintenance records, including proper procedures in the event of failures and instances which might affect the validity of warranties, bonds, or contracts.
 - 5) A parts catalog enumerating every part to the lowest of card replaceable components. The description shall include component symbol, description, ratings, accuracy, manufacturer's name and address, manufacturer's part number, commercial equivalents, and quantity per assembly or subassembly. The parts catalog shall identify the appropriate locations of the parts and shall group each component by

assemblies or subassemblies within each subsystem so that each component can be identified as being part of the next larger assembly.

- 6) A list of recommended spare parts that includes all parts necessary to maintain and repair control system components. The list shall identify the specific part or model number, description, manufacturer's name and address, commercial equivalents, unit price, lead time for delivery, and recommended quantity. The spare parts list shall indicate which components (by model and serial number) have been provided with the delivered system as part of the spares inventory.

5. Drawings

- a. O&M Manual drawings (with the exception of those provided by third-party manufacturers) shall not be larger than 11-inches by 17-inches and shall be clearly legible when reproduced using conventional office copying machines. Originals shall be provided for all third-party O&M Manual materials. One reproducible of the O&M Manual drawing original must be supplied for each O&M Manual drawing larger than 11 inches by 17 inches, and must satisfy all drawing requirements specified herein. Those preprinted O&M Manual drawings which are not acceptable, or which must be modified or corrected to show the actual as-built design, shall be redrawn as new specially-prepared shop drawings. Acceptable equipment manufacturer's drawings incorporated into equipment operating and maintenance manuals need not be duplicated or removed from the manuals.
- b. Furnish drawings on paper and in the latest AutoCAD electronic format.
- c. Each O&M Manual shall be bound in 8 1/2" x 11 inch 3-ring side binders with commercial quality hardback, cleanable plastic covers. Maximum of 3" binder size.
- d. Binder covers shall contain the printed title "Operation and Maintenance Instructions",
- e. The manuals shall be internally subdivided with permanent page dividers with tab titling clearly printed under reinforced laminated plastic tabs.
- f. Each volume shall have a Table of Contents, with each product or system description identified.

E. Record Documents

1. After successful Site Demonstration Test, Submit for review the Record Documents (as-built) for all equipment and software installed by the Contractor. All documents which have changed because of the engineering changes, contract changes, or error or omission shall be updated and the revised documentation provided.
2. Furnish complete as-built sets of:
 - a. Source tapes, disk pack(s) or other storage media for all custom programs
 - b. Loadable and executable object disk pack(s) of the software systems
 - c. All previously delivered documents, with as-built updates
 - d. OEM standard documentation.
3. These media shall include the operating systems, all programs necessary for the operation as well as maintenance of the System, and all programs supplied by the CPU/Microprocessor manufacturers, such as assembler, loaders, editors, compilers and diagnostics.
4. The documentation as outlined in this portion of the document, in conjunction with other documentation specified elsewhere in this document, shall be sufficient to allow the Owner to reconfigure or make additions or deletions to the System without assistance from the Contractor.

F. Testing Documentation Submittals. Submit testing plans to meet the requirements listed in Part 3 – Execution of this Article and the subsequent reports resulting from the testing. The following paragraphs describe the general content of each submittal.

1. System Test Plan. The system plan describes the overall system testing. As a minimum, the plan shall include the general objectives of the test; the delineation of responsibilities of the Owner, Owner's Representative, and Contractor during the test; any initial coordination issues; the location of the testing; a general description of each phase of testing or subsystem test; a description of the expected results; and a description of the procedures for the tracking of the test procedures, as well as any issues and problems that might result from the testing. This plan does not list the specific test procedures.

2. Test Procedures. This test plan is a document that lists the specific tests. Each test should include a description or listing of any setup requirements, the test procedure, and the expected results.
3. Test Reports. The test reports are the documents prepared during the actual testing. These reports shall also include any documentation of any problems and the resolution of those problems.

PART 2 - P R O D U C T S

2.01 INFORMATION ON DRAWINGS

- A. The following information is indicated on the Drawings:
 1. Loop diagram on flow sheet for each control loop. Diagrams are schematic in nature and intended only as a guide to work to be performed.
 2. Approximate location of primary elements, instrument panels and final control elements.
 3. Approximate location of instrumentation power junction boxes for instrument electrical power connection.
 4. Location of electrical distribution panel boards for instrument electrical power.
 5. Location of equipment having alarms and equipment status contacts.
 6. Location of equipment being controlled by system.
 7. General layout of instrument cabinets.
 8. Instrument installation details.
- B. The following information is not shown on Drawings but shall be the responsibility of the Contractor to determine, furnish and coordinate with other divisions, based upon systems specified. Show this information on project Record Drawings.
 1. Instrument loop drawings per ANSI/ISA S5.4 minimum, desired and optional items.
 2. Location of electrical distribution panel boards supplying power to any device supplied under this contract.
 3. Detailed enclosure and instrument panel layouts, fabrication details and wiring diagrams.
 4. Detailed system configuration.
 5. Raceway and cable routing for instrumentation wiring.

2.02 OPERATING CONDITIONS

- A. Ambient Conditions. Provide equipment suitable for project ambient conditions specified. Provide system elements to operate properly in the presence of radio frequency fields produced by portable RF transmitters with output of five watts operated at 24 inches from instruments; in the presence of plant telephone lines,

power lines and electrical equipment; and in the presence of digital data transmission systems.

- B. Field Locations. Field equipment may be subjected to ambient temperatures from -5 to 50°C with direct radiation, relative humidity from 0 to 100 percent with condensation.
- C. Power Supply. Power supply will be 117 volts AC, single- phase, 60-hertz commercial power. Voltage variations will be at least plus or minus 8 percent. Ensure that analog signal loops incorporate adequate power supply capacity for operations.

2.03 TRANSIENT AND SURGE ISOLATION

- A. Protect all power and communication and transmission/ receiving circuitry from any surge, including spikes up 1,000 volts peak and surges with a rise time of less than one microsecond. Use a combination of current limiting resistors, zener diodes, gas tube surge arresters and a fusible link which melts and shorts the surge to ground before the device circuitry is affected. Provide protection adequate for personnel safety, which will prevent an erroneous output, change in calibration or failure of component other than fuse or fusible link.

2.04 SPARE PARTS

- A. When required spare parts are utilized during construction to correct a faulty condition, replace spare part in kind.

2.05 SPECIAL TOOLS

- A. Supply one of each type of special hand tool required to open or operate equipment, to remove or replace replaceable parts, remove or replace cable connectors, or to make required operational or maintenance adjustments. A special hand tool is any tool not readily available from local retail hardware stores.

2.06 TEST EQUIPMENT

- A. Provide a complete list of all tools, test equipment, and commercial software programs necessary for the proper maintenance of the system. This list shall contain the quantity recommended, model number, description, cost, and name and address of supplier.

2.07 MATERIALS AND EQUIPMENT

- A. Materials. Material shall be new, free from defects, and of the quality specified. All instruments with the same specification shall be from the same manufacturer.

1. Provide equipment of solid-state construction utilizing second source semiconductors, unless otherwise specified. Derate components to ensure dependability and long-term stability. Provide printed or etched circuit boards of glass epoxy, hand or wave soldered, of sufficient thickness to prevent warping. Coat printed circuit boards in field-mounted equipment with Plasite 7122, or approved equal, to protect against corrosion. Alignment and adjustments shall be non-critical, stable with temperature changes or aging and accomplished with premium grade potentiometers. Do not insert components of specially selected values into standard electronic assemblies to meet performance requirements. Use parts indicated in instruction manuals, replaceable with standard commercial components of the same description without degrading performance of completed assembly. Do not use silver edge connectors or pins.
2. Use test equipment and instruments to simulate inputs and read outputs suitable for purpose intended and rated to an accuracy of at least five times greater than the required accuracy of device being calibrated. Such test equipment shall have accuracies traceable to the National Bureau of Standards as applicable.
3. Make equipment located in hazardous areas suitable for applicable classification by use of explosion-proof housings or equipment and barriers approved as "intrinsically safe" by either UL or FM. Locate barriers in cabinets at hazardous area boundaries. Use dual barriers in loops in order to prevent grounding loop at the barrier.

PART 3 - EXECUTION

3.01 SPECIAL PROJECT REQUIREMENTS

- A. Coordinate with all the sub-systems suppliers and manufacturers, during bidding, construction, testing, installation and start-up phases of the project. The coordination is to assure that the instruments, and sub-systems are in compliance with the Specifications and the central controls, and that the tie-ins and the interface signals are provided as required.
- B. The calibration, testing and start-up of all the instruments shall be done by the manufacturer's field technician/engineer in the presence of the Owner. Provide a list of all manufacturers whose technician will perform this work. Provide a certified calibration report stating that each instrument has been installed per manufacturer's recommendations and per these Specifications.

3.02 SYSTEM DESIGN

- A. Provide hardware, software and program development to satisfy the instrumentation and control system described in the contract documents.
- B. Prepare design submittals, as directed by the city, or review by the Owner. These design submittals shall be in accordance with the submittal paragraph of this specification.
- C. Configure and program the control system to meet the functional and performance requirements of the contract documents. This shall include the development of:
 - 1. System point input/output list.
 - 2. Control logic to implement the control strategies described in the contract documents.
 - 3. Configuration and programming of the field units with the control logic.
 - 4. System database and point naming (tagging) conventions.
 - 5. Development and implementation of custom operator interfaces and screens.
 - 6. Configuration and implementation of the system reporting to include alarm configuration and reporting.
 - 7. Design, configuration and any programming of the system communication network.
- D. Install, connect, tune and perform all necessary startup of the system in accordance with the contract documents
- E. Perform all system testing described in the System Test Requirements paragraph of this article.

3.03 SYSTEM TEST REQUIREMENTS

A. General Requirements

- 1. The Control System shall undergo a comprehensive system test process to demonstrate that the system performs as an integrated unit to meet the requirements of this specification. As a normal course of system development, conduct all element, subsystem, and system tests necessary to ensure the proper operation of the control system at various stages of system development. This type of testing will normally be not witnessed; however, the Owner and Owner's Representative reserve the right to witness these tests if concerns arise about the progress of system implementation.
- 2. One (1) final witness tests shall be conducted on the Control System:
 - a. Field I/O Point Checkout
 - b. Field or Site Acceptance Test

3. The following paragraphs describe the requirements for each of these formal tests.

B. Field I/O Point Checkout

1. An I/O point-to-point test shall be performed after all equipment is shipped and installed in the field. This is an end to end test to verify that the equipment has been installed correctly.
2. The Owner and the Owner's Representative will witness this test.
3. The I/O point checkout shall demonstrate the proper operation of all the field points affected by the installation of the equipment provided by this contract.
4. Provide an I/O list for each field unit provided under this contract,
5. The I/O Point Checkout shall include, but not limited to, the following:
 - a. Exercise each discrete input. Each state shall be verified at the field unit and the Operator Workstation.
 - b. Exercise each analog input. Each input shall be verified at 0, 50 and 100% range of the instrument. Linearity of the signal shall be verified. Each value shall be verified at the field unit and Operator Workstation.
 - c. Exercise each discrete output. Each state shall be initiated from the Operator Workstation. If necessary, the associated equipment shall be placed into a "safe" state such that the activation of the output will not damage the equipment or cause a safety hazard.
 - d. Exercise each analog output. Each output shall be verified at 0, 50 and 100% range of the instrument. Linearity of the signal shall be verified. Each value shall be initiated and verified at the Operator Workstation.
 - e. Unless constrained by the operation of the plant, or due to safety reasons, all testing should include the actual equipment, and not use simulated signals.

C. Field or Site Acceptance test

1. Conduct a site acceptance test to demonstrate the proper implementation, installation and startup of the control system logic and software using the actual devices and plant equipment.
2. Conduct this test in accordance with the approved test plan submitted under paragraph 1.6 of this specification.
3. This test shall include but is not limited to the following:
 - a. Demonstrate the communication between the local operator interfaces and field units.
 - b. Demonstrate communication between the control room and field control units.
 - c. Demonstrate any peer-to-peer communication

- d. Demonstrate the capabilities to upload, modify and download control logic to field control units
- e. Demonstrate that the control logic and programming has been installed and implemented in accordance with the project control strategies and contract documents. This test shall demonstrate this on a subsystem then system wide basis
- f. Demonstrate the plant equipment responds properly to operator commands
- g. Demonstrate any plant interlocks function properly and in accordance with control strategies and contract documents.
- h. Demonstrate system reporting and proper report formats
- i. Demonstrate system event and alarming functions in accordance with the approved design and contract documents.

3.04 INSTALLATION AND STARTUP

- A. Install the new equipment in accordance with the Drawings and Specifications.
- B. Coordinate with the Owner to keep the Owner processes operating during the installation and cutover phases of the project.
- C. Provide any temporary power and/or controls necessary to keep the Owner's processes operating during the installation of the new equipment.
- D. Coordinate any startup testing of new equipment with the Owner prior to the actual testing. Startup testing is defined as any Contractor test to verify to the Contractor's satisfaction that the new equipment has been installed in accordance with the manufacturer's recommendations and the Drawings and Specifications. Testing shall not be a substitute for the formal testing listed under Paragraph 3.3 System Test Requirements of this specification.

3.05 TRAINING

- A. Conduct the following training;
 - 1. Operator training:
 - a. The objective of the operator training is to provide the Owner's operational personnel with the knowledge necessary to properly use the new equipment to perform their day-to-day duties as plant operators.
 - b. Operator training shall utilize the project O&M manuals as a basis for this training.
 - c. Submit to the Owner a course outline or syllabus for the topics to be covered in the operating training.
 - d. As a minimum the operator training shall include but is not limited to:

- 1) The HMI equipment in the main control room and any remote control areas.
 - 2) The general functioning of the communication network
 - 3) The graphic screens interfaces for the HMI.
 - 4) Operator actions with the HMI and interactions with the plant processes.
 - 5) Alarm and event functions
 - 6) Reporting functions
2. Maintenance training:
- a. The objective of the maintenance training is to provide the Owner's maintenance personnel with the knowledge necessary to properly perform maintenance activities on the system to include preventive and corrective maintenance.
 - b. Maintenance training shall utilize the project O&M manuals as a basis for this training.
 - c. Submit to the Owner a course outline or syllabus for the topics to be covered in the maintenance training.
 - d. As a minimum the maintenance training shall include but is not limited to:
 - 1) Preventive and maintenance schedule(s) shown in the O&M Manuals.
 - 2) The general functioning of the communication network and trouble shooting of communication errors.
 - 3) The functioning of the field equipment, instruments, and HMI equipment
 - 4) Use of any diagnostic software provided with the system
 - 5) Use of any special tools provided with the system.
 - 6) Instrument calibration procedures and schedules.
- B. The CONTRACTOR has the option of utilizing manufacturer training personnel to meet the requirements of the operator and maintenance training. The demonstration and training may be combined into a common session.

END OF SECTION

ATTACHMENT A

This attachment is a summary of the instrumentation and controls-related work at the required site. This is NOT intended to serve as a basis for bidding purposes, but as a general outline of the required tasks. The Contractor shall still be responsible to provide the hardware and software necessary for a functional instrument and control systems at the sites addressed in the project drawings and specifications.

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- Provide program software changes for the new west Metering Station for controlling the metering pressure reducing valve:
 1. Remove existing programming for the operation of motorized ball valve and associated strap-on magnetic flow meter for West Metering Station. All related alarms for tank level, flows, and pressure signals shall unchanged.
 2. Provide programming to allow control of the new metering pressure reducing valve for the following modes of operation:
 - a. Flow Setpoint: Provide a variable flow rate setpoint, through use of existing HMI/SCADA Network, so that Operations can input the desired flow rate through the metering pressure reducing valve. SCADA shall transmit this setpoint to the manufacturer's metering pressure reducing valve controller located out near the valve in adjacent control panel. The valve controller program/operation shall be performed by metering pressure reducing valve manufacturer and shall provide a feedback 4-20mA signal of corresponding flow rate sensed by the metering valve. SCADA shall provide the feedback flow rate to SCADA Network and HMI Interface for display. The PLC program shall shutdown flow through the valve should the Ground Storage Tanks be full or upstream pressure drop below an adjustable SCADA/HMI preset value with adjustable dead band. Once the tank level drops below a below an adjustable SCADA/HMI preset value, flow shall resume to the flow rate setpoint.
 - b. Tank Level Setpoint: Provide tank level rate setpoint through use of existing HMI/SCADA Network, so that Operations can input the desired tank level which will provide signals (desired level and actual level) to the metering pressure reducing valve controller to modulate valve through PID control to maintain tank level within an adjustable deadband set within the valve controller. The valve controller program/operation shall be performed by metering pressure reducing valve manufacturer and shall provide a feedback 4-20mA signal of corresponding flow rate sensed by the metering valve. SCADA shall provide the feedback flow rate to SCADA Network and HMI Interface for display. The PLC program shall shutdown flow through the valve should the Ground Storage Tanks be full or upstream pressure drop below an adjustable SCADA/HMI preset value with adjustable dead band. Once the tank level drops below a below an adjustable SCADA/HMI preset value, flow shall resume through the valve base on PID control in the valve controller.

END OF ATTACHMENT

SECTION 13413

CONTROL PANELS

PART 1 - G E N E R A L

1.01 SUMMARY

- A. Furnish, deliver, and install the control panels as shown on the Drawings with power supplies, communications equipment, incoming power surge suppression, and miscellaneous equipment to provide a fully functional system as shown on the Drawings and specified herein.
- B. All work and products shall conform to the designs shown on the applicable Drawings, and shall comply with the provisions of this section. Panels and cabinet shall include all components indicated in the applicable Drawings, required to provide functions as specified in this section. Where specific requirements on the Drawings conflict with general design requirements in this section, the requirements shown on the Drawings shall prevail.

1.02 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Instrumentation & Control (SCADA) per project site.

1.03 REQUIRED PANELS

- A. Panels shall conform to the requirements indicated on the Drawings and specified herein

1.04 QUALITY ASSURANCE

- A. All equipment and accessories provided shall be the product of a manufacturer regularly engaged in manufacturing of this equipment whose products have been in satisfactory service for not less than three (3) years.

1.05 PANEL COMPONENT LAYOUT

- A. Follow the arrangements of components shown on the Drawings. Make adjustments as necessary to allow each component to be mounted as recommended by the manufacturer, to facilitate easy installation, removal and in-place maintenance of each component, and to allow normal operation of the component by operating and maintenance personnel. Component arrangements shall allow space for routing of wiring without kinking or bending around sharp

edges, and for free flow of air around and through equipment, which requires ventilation for cooling.

1.06 WARRANTY

- A. Provide an all-inclusive two (2)-year warranty for labor and materials

1.07 TRAINING

- A. The manufacturer shall provide operating training and maintenance training as detailed in the Specifications.

1.08 SPARE PARTS AND TOOLS

- A. The manufacturer shall provide spare parts and/or tools required to perform standard maintenance for up to five years after acceptance

1.09 REFERENCE STANDARDS

- A. All materials and workmanship shall conform to the latest published applicable provisions of the following codes and standards:

Standards	Title
ANSI/NFPA 70	National Electrical Code (NEC)
ANSI/NEMA ICS 1	General Standards for Industrial Controls and Systems
ANSI/NEMA ICS 2	Industrial Control Devices, Controllers, and Assemblies
ANSI/NEMA ICS 3	Industrial Systems
ANSI/NEMA ICS 4	Terminal Blocks for Industrial Control Equipment and Systems
ANSI/NEMA ICS 6	Enclosures for Industrial Controls and Systems
ANSI/NEMA 250	Enclosures for Electrical Equipment (1000 Volts maximum)
EIA RS-310-C	Racks, Panels, and Associated Equipment
ANSI-C-37.13	Low-Voltage AC Power Circuit Breaker (600 Volt Insulation Class)

ANSI/IEEE-C-37.90-1 Standard for Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus

ANSI/IEEE C39.5 Electrical Isolation for Analog Signal Devices

- B. Unless otherwise specified, electrical equipment and material provided under this contract shall be listed and labeled for the purpose for which it is used by the Underwriters Laboratories, Inc. (UL). This requirement may be waived only if a UL listing is not available for the type of product and approved by the Owner's Representative.

1.010 SUBMITTALS

- A. Product Data. Provide product data sheets for each item utilized.
- B. Elementary Control Diagrams. Provide elementary control diagrams, using the ladder diagram format incorporating line number, operation function statement, contact location line number with an underline for a normally closed contact and a description of operation of each device. Label each contact, coil, and indicator with its function, as well as its number. Show terminals for field wiring. Show field wiring as dashed lines.
- C. Panel Layout drawings. Show the general arrangement of the equipment within the control panel. The view shall be from the front of the panel with an open door. Include any section views necessary to present a clear picture of equipment mountings and clearances.
- D. Connection Diagrams. Provide connection diagrams which show the following:
 - 1. Placement, labeling and wiring of components within panels and cabinets.
 - 2. Components arranged in the physical layout (not necessarily to scale) as it would appear to a person servicing the equipment.
 - 3. Wires as a continuous line between their termination points.
 - 4. The direction of entry to a wire bundle.
 - 5. Wire lists and wireless diagrams are not acceptable.
 - 6. Additions and deletions of devices and wires in existing enclosures.
 - 7. Each wire label designation.

8. Identical wire label designations on each end of a single wire.
9. Wire termination point numbers.
10. Each wire color.
11. Signal and DC circuit polarities.
12. Jumper, shielding and grounding details.
13. Wire pairs.
14. Spare wires and termination points.

PART 2 - PRODUCTS

1.011 CONTROL PANELS

A. Physical and Miscellaneous Specifications

The enclosures shall:

1. Be NEMA 4 painted steel with 3 point latching handle.
2. Contain surge arresters, terminal strips, nameplates, terminal labels, wire ducts, universal spiral wraps and any necessary parts for a complete systems as shown on the Drawings and specified herein.
3. Be wall mount or free standing as appropriate for the application.
4. Allow expansion space to accommodate future system needs.

1.012 PANEL FABRICATION

A. Materials. The enclosure shall be made with 12 gauge minimum. Each shall be provided with a full length interior panel with adjustable mounting on both vertical sides to rails located at the top, bottom, and middle of the enclosure.

B. Acceptable manufacturers:

1. Hoffman Engineering Company (www.hoffmanonline.com)
2. Rittal (www.rittal.com)
3. Approved equal.

C. Dimensions. Panels shall be sized by the Contractor to accommodate all initial and future devices.

D. Coating

1. Metal surfaces of NEMA 4 panels and cabinets shall be prepared, primed and finish coated in accordance with the requirements of the Specifications and coating manufacturer's recommendations. Scratches or blemishes in panel faces shall be filled prior to finishing. One coat of primer shall be applied at the manufacturer's recommended dry film thickness and allowed

to dry prior to applying the first finish coat. Provide a quart of finish paint from batch used for final finish coat.

2. Finish coat shall be aliphatic air-dry polyurethane or epoxy panel enamel. Cabinet interiors shall be Fed. Std. color 27880, white. Exterior color of cabinets shall be Fed. Std. 26306, gray.

E. Miscellaneous

1. All miscellaneous hardware and fittings shall be stainless steel. Stainless steel shall meet or exceed the corrosive-resistant properties of stainless steel.

1.013 NAMEPLATES

- A. Machine engraved, three ply laminated phenolic nameplates shall be provided for all panels and cabinets as shown on the Drawings. Nameplates shall be black with white lettering. Nameplates shall be attached to the panel with a minimum of two self-tapping stainless steel sheet metal screws. The height of each character shall be a minimum of 3/16" except as noted.

1.014 WIRING AND ELECTRICAL DEVICES

- A. General. Provide electrical devices specified below and associated wiring to provide a fully functional control panel system.

B. Panel Connection Wire and Cable

1. All cable furnished by the Contractor, including cable with any and all wires terminated at both ends within the same panel or enclosure and cable with any wires terminated at more than one panel or enclosure, shall conform to the requirements specified below.
 - a. Power and Control Cable - Power and control wiring shall conform to Section 16120.
 - b. Single Conductor Wire - All single conductors used for logic, PLC/RTU input/output and discrete control circuit wiring shall be No. 18 AWG stranded conductor copper, Belden Type 9918 (0.080-inch O.D.), or equal.
 - c. Multi-conductor Foil-shield Cable (TP) - All multi-conductor cable used for logic, PLC/RTU input/output and discrete control circuit wiring shall be No. 16 AWG stranded copper conductors with polyvinylchloride jacket. The cable shall be rated for a minimum of 600 volts and 80°C. The cable shall have an overall aluminum/polyester foil shield with drain wire, Alpha XTRA-Guard 1, or equal.

- d. Analog Signal Cable - Wiring for 4-20 milliampere, 1-5 volt DC signals and other analog signals shall be No. 18 AWG stranded copper twisted pair shielded cable, 80°C rated, UL listed, 0.25 inches maximum outside diameter, with 100 percent coverage aluminum foil mylar-lines shield and No. 22 AWG (minimum) stranded tinned copper drain wire, Houston Wire and Cable, Belden, or equal. Multi-pair analog signal cable shall be individually shielded (with drain wire) No. 18 AWG stranded conductor copper with a 100 percent aluminum/polyester foil shield with drain wire and an outer PVC jacket. The cable is designated TSP on the Drawings. The cable shall be rated for 600V, 80°C (NEC Article 300-3).
 - e. Multi-Individual Conductor (TP) Multi-individual conductor cables used for logic, PLC/RTU input/output and discrete control circuit wiring shall be number 16 AWG stranded copper conductors with polyvinyl/chloride jacket . The cable shall be rated for a minimum of 600V and 80°C. The cable shall be Belden, or equal.
- 2. Wire Tagging. All panel connection wiring shall be tagged at terminations with machine printed slip on type tags. Show wire/cable tag designations on all wiring diagrams submitted to the Owner. There shall be a tag placed within two inches of any wiring termination. The tag shall be fixed to the wire to prevent the tag from sliding more than two inches from the terminal as the result of gravity and vibration.
 - 3. Control circuit, logic bus and power circuit wires shall be tagged as follows:
 - a. Control Circuits. Each individual connection wire shall be tagged at both ends of the wire with a wire number. The tag shall be placed on the wire within two inches of the terminal to which the wire is terminated. Assign a unique number for each wire within a panel.
 - b. Power Circuits. All 120 VAC power wires shall be tagged with the designation "120 VAC-" followed by the circuit breaker number shown on the Drawings, then followed by a letter designating whether the wire carries the line (L), neutral (N) or power ground (PG).
 - 4. Wire Colors. Control, logic bus and power conductors in panels shall have the following insulation colors:

Usage	Color
Line Power	Black
Neutral	White
Power Ground	Green
Control	Red
Status and Alarm	Blue

5. Signal Circuits. Signal circuit multi-conductor cables shall be tagged at each end with the designation shown on the wiring diagram. Each signal conductor shall be tagged at each end with the designation of the terminal block to which it is connected. Individual conductors in each pair of twisted-pair cable shall have distinctly different colors, such as black and white, black and clear. Shield ground common wires connected between drain wire terminals shall be green and shall be tagged "SG".

C. Terminal Blocks

1. Unless otherwise shown or specified, terminal blocks shall be captive screw with pressure plate, DIN EN 50035 rail 600 volt rating. Terminal blocks for Input/Output shall be prewired type as specified in section 17300. Terminal blocks shall be the type specified in the following table, or equal:

Description	Type	Application
Grounding Terminal	Phoenix USLKG 5	Equipment Grounding Block
End Clamps	Phoenix E/NS 35 N	Each Group of Blocks
Terminal Marking	Phoenix ZB 6	All terminal Blocks as required
Terminal Strip Marker	Phoenix KLM-A	Each Group of Blocks
Insertion Strip	Phoenix ESL	As Required

- D. Terminal Tags, Covers and Markers. Each terminal strip shall have a unique identifying alphanumeric code designation at one end and a plastic marking strip running the entire length with a unique number for each terminal. Assign terminal strip numbers from the number "1" and continuing in ascending cardinal order. The terminal strip designation shall be the letters "TB" followed by the terminal strip number. The strip and terminal point designations shall be machine printed and 1/8 inch high. Terminal blocks carrying 120 VAC power circuits shall be provided with a transparent, hinged cover for personnel protection and accessibility.
- E. Wire Routing. Wires shall be routed in slotted plastic wire-ways with snap covers. Wires carrying 120 VAC shall be separated from other wires and signal cables, and shall be routed only in ducts shown on the Drawings to be for 120 VAC. If the power wiring has to cross the signal wiring, the crossing shall be as close to a right angle. Ducts shown for 24 VDC shall be used for all other wires and cables. Wires and cable shall be routed along the shortest route between termination

points, excepting routes which would result in routing 120 VDC and other wires and cables in the same duct. For intrinsically safe signal wiring refer to ANSI/ISA RP12.6 "Installation of Intrinsically Safe Instrument Systems in Class I Hazardous Locations." Wires and cables shall have sufficient length to allow slack and to avoid any strain or tension in the wire or cable. Wires and cables shall be placed in the ducts in a straight, neat and organized fashion and shall not be kinked, tangled or twisted together.

F. Wire Terminations

1. Single wire and cable conductors shall be terminated according to the requirements of the terminal device.
2. For captive screw, pressure plate and screw terminals, appropriately sized lugs shall be used. Lugs shall be crimp on type that form a tight connections. All crimping shall be done using a calibrated crimping tool made specifically for the lug type and size being crimped.
3. On shielded cables, the drain wire shall be covered with insulating tubing along its full bare length between the cable jacket and the terminal lug or terminal pressure plate.

G. Cabinet Lighting. Each panel shall be provided with an internal fluorescent light. Lights shall operate from 120 VAC, and shall be wired to power through a door-mounted switch, which shall be activated by opening the cabinet door, to be located and wired as shown. Cabinet lights shall be Hoffman ALF16D18R, or equal.

H. Circulation Fan. Provide a 120-volt circulation fan with mounting bracket in each panel. Fan shall be 4" capable of 100-cfm.

I. Analog Input and Output Wiring Requirement:

1. Each analog I/O shall have a voltage surge arrester in circuit to protect analog input from the any electronic surge damage. Phoenix Contact DIN mounted overvoltage arrester PLUGTRAB PT or TERMITRAB series shall be used in each analog circuit, including all spare I/O. Provide a fuse for each analog signal.

J. Panel Ground

1. Each panel shall be provided with a 1 inch high x 0.25 inch thick solid copper grounding bus bar across the bottom of the panel. The grounding bar shall be mounted on insulated standoffs so that no electrical connection is made between the grounding bar and the cabinet through the mounting. The ground bar shall be drilled and tapped for a .25-20 screws at .5 inch intervals along its entire length.

2. An uninsulated solid copper #8 AWG ground wire shall be attached between the ground bar and the panel enclosure, and between the ground bar and the mounting panel.
- K. Condensation Heater. Provide thermostatically operated condensation space heaters, which are sealed and safe to touch.
- L. Wiring Duct. Plastic wiring duct shall be slotted type with dust cover, panduit type e or ne, as required.

PART 3 - EXECUTION

3.01 TEST REQUIREMENTS

- A. Test the panels and correct any defects. These tests shall consist of the following:
 1. Verify that each wiring connection is made properly by checking electrical continuity, ensuring that connections have less than one Ohm resistance end to end, and that no cross continuity exists between separate circuits.
 2. Functionally test each electrical device to verify correct operation. Test each input/output point. Inputs shall be exercised at the location in the panel the greatest distance in the circuit from the PLC/RTU chassis and verified through to the PLC/RTU processor. Results shall be demonstrated on a programming terminal. Each output shall be exercised from a programming terminal and verified through to the panel location the greatest distance in the circuit from the PLC/RTU chassis. Analog inputs and outputs shall be tested at 0%, 25%, 50%, 75%, and 100% of range. This test shall be witnessed by the Owner's representative and certify the results in writing to the Owner. Test the operator interface unit, including simulated alarm conditions.
 3. Test Ground Fault Interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle manufacturer.

END OF SECTION

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SECTION 13420

INSTRUMENT COMMISSIONING

PART 1 - G E N E R A L

1.01 SUMMARY

- A. Provide instrument commissioning including but limited to inspection, operational testing, adjustment and calibration of each device, subsystem and system and placement of each device and system into service.

1.02 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Instrumentation & Control (SCADA) per project site.

1.03 SUBMITTALS

A. Test Plan:

- 1. At least 30 days before commissioning starts, submit a description of the tests to be conducted.
- 2. Include list of test equipment, test procedures, check- lists and test report formats.
- 3. At the completion of each commissioning phase, deliver all test reports for that phase to Owner's Representative with statement that phase test requirements have been satisfied.
- 4. Make shop drawing distribution.

- B. Responsibility. Review for acceptance by the Owner's Representative of any plan, report or other commissioning activity will not relieve the Contractor of his responsibility to meet the contract requirements.

- C. Description. Provide field instrumentation accessories to complete installation of sensors, meters, switches, transmitters and similar devices.

1. Each installation includes:

- a. Device.
- b. Mounting stand where required.
- c. Process leads, connectors, valves, support means and all other devices and material required for a complete installation.

1.04 QUALITY ASSURANCE

A. Referenced Standards:

1. ANSI C37-90a.
2. API RP550.
3. ASTM 153.
4. ASTM B 62.

B. Factory Testing:

1. Subject each device to a complete functional test.
2. Wet flow calibrate flow meters to within specified accuracy.
3. Submit a certified calibration report for each meter showing results of calibration at a minimum of five points evenly spaced throughout range.
4. Apply a Surge Withstand Capability test wave:
 - a. As defined in Section 2 of ANSI C37.90a-1974, to each power supply circuit, battery circuit, signal circuit, output circuit and input circuit.
 - b. Application of test wave shall be as described in Section 4 of ANSI C37.90a-1974.
 - c. Submit a certified copy of test showing the no load test waveform, details of test wave generator circuit and description of test conducted.

1.05 SUBMITTALS

A. Product Data:

1. Submit vendor specification information along with a corrected copy of applicable specification form for each scheduled device specified in this section.
2. Submit vendor specification information for each material and unscheduled device specified in this section.

PART 2 - P R O D U C T S

2.01 MATERIALS

- A. Devices and systems are specified in other sections of this Specification. Reference to "devices" means all devices included in the contract.
- B. Any device that fails to meet contract requirements or published performance specifications of the manufacturer must be repaired or replaced as directed by the Owner's Representative at no cost to Owner.
- C. Demonstrate that test equipment is fully operational and properly calibrated.
- D. The Owner's Representative reserves the right to disapprove test equipment that is improper or functioning improperly.

PART 3 - EXECUTION

3.01 OBSERVATION

- A. The Owner's Representative reserves the right to witness any test, inspection, calibration or start-up activity.
- B. Notify the Owner's Representative in writing at least 24 hours in advance of any test. All tests executed without notifying the Owner's Representative are invalid and must be repeated.
- C. Perform commissioning of each device, subsystem and system under direct supervision of the individual manufacturer's factory-trained representative.

3.02 REPORTS

- A. Prepare report showing test procedures, conditions and results of each test. In the test report, give applicable contract requirements, manufacturer's performance specifications, and permissible tolerances at each test point, actual values of test signals and actual values of test results. Provide report bound in a three ring binder.
- B. Check off List:
 - 1. Maintain a check off list by loop number indicating tasks remaining to be done to make loop operational.
 - 2. Submit check off list form at least 60 days before commissioning starts.
 - 3. Submit check off lists when requested by Owner's Representative.
 - 4. Lists will be requested no more frequently than once a week.

3.03 SCHEDULING GUIDELINES FOR COMMISSIONING PHASES

- A. Perform all commissioning in accordance with the instructions on the Contract Drawings, these Specifications, manufacturer's instruction manuals and the direction of the Owner's Representative.
- B. Commission field devices, after installation of field instruments and prior to commissioning the instrument or the control panel.
- C. After installation of the instrument or control panel and prior to loop commissioning, commission panel-mounted devices and systems.
- D. After commissioning field devices and panel-mounted devices, commission loops.

3.04 REQUIREMENTS

A. Transmitters and Receivers:

1. Remove shipping stops before starting with these procedures.
2. Have manufacturer's instruction manuals available.
3. Install miscellaneous components such as charts, illumination, etc., which have been supplied separately but are integral parts of equipment.
4. Test and exercise each instrument to demonstrate correct operation, first individually, then collectively as a functional network.
5. Check calibration of and recalibrate, where necessary, instruments at a minimum of four points over full operational range and prove instruments to be within specified accuracy.
6. Calibrate instruments individually and, where applicable, as loop (i.e., transmitter, controller and valve).
7. Specified accuracy for loop is defined as root-mean-square-summation (RMS) of individual device specified accuracies.
8. Individual device specified accuracy requirements shall be as specified by contract requirements or by published manufacturer accuracy specifications whenever contract accuracy requirements are not specified.
9. Test each loop by applying simulated analog and/or discrete inputs to first elements of loop (i.e., applying simulated analog and/or discrete sensor signals) and measuring outputs from final elements of loop, (i.e., controllers, alarms, indicators, etc.).
10. Apply continuously variable analog inputs to verify proper operation and setting of discrete devices (i.e., alarms, etc.).
11. Make provisional settings on controllers, alarms, etc., during loop installation tests.
12. Prepare calibration report on each instrument and loop.

B. Flow Meters:

1. Perform volumetric draw down of fill test for all liquid flow meters.
2. Prepare test report for each meter transmitter.
3. If test results conflict with calibration report, recalibrate in accordance with subparagraph A above, and repeat volumetric draw down or fill test.
4. Continue until draw down test results prove calibration to be correct.

C. Controllers:

1. Check control action of each controller.
2. Check calibration of gain, integral and rate adjustments where specified including all modes of operation.
3. For each setting, check output for at least three inputs evenly spaced through input range.
4. Check at least three settings for each adjustment evenly spaced throughout the adjustment range.
5. Run all diagnostic procedures.

D. Start-up of Instruments:

1. Test each control loop under start-up and steady-state operating conditions to verify that proper and stable control is achieved using instruments in each instrument panel and control panel.
 - a. Test control of final control elements using specified modes of manual and automatic control.
 - b. Demonstrate bumpless transition between control station modes.
 - c. Use signals from transducers, sensors and transmitters.
 - d. Simulated input data signals may be used subject to prior written approval by the Owner's Representative.
2. Set proportional band, reset rate and derivative settings for each control as recommended by manufacturer.
3. Verify transient stability of each control loop by applying control signal disturbances, monitoring amplitude and decay rate of control parameter oscillations and making necessary controller adjustments to eliminate excessive oscillatory amplitudes and decay rates while retaining control sensitivity. Verify proper suppression of "reset wind-up."

E. Component Calibration Sheet

1. Calibrate and ring out all devices that are to be interfaced with the distributed control system, including devices purchased and installed under other contracts.
2. Each active instrument element (except simple hand switches, lights, etc.) and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for signoff by the Contractor.
 - a. Project name.
 - b. Loop name.
 - c. Component tag number or I/O module number.
 - d. Component code number.
 - e. Manufacturer.
 - f. Module number/serial number.
 - g. Summary of function requirements.
 - h. For indicators and recorders. scale and chart ranges.
 - i. For transmitters/converters. input and output ranges.
 - j. For computing elements.
 - k. I/O modules. required and actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
 - l. Space for comments.
 - m. Space for signoff by Contractor.
3. Maintain the Loop Status Reports and Component Calibration Sheets at the job site and make them available to the Owner's Representative at any time.

END OF SECTION

SECTION 13421

INSTRUMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This section of instrumentation covers field instruments.
 - 1. Pressure Transmitters
 - 2. Chlorine Analyzers

1.02 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Instrumentation & Control (SCADA) per project site.

1.03 QUALITY ASSURANCE

- A. All instruments shall be of quality as specified.
- B. Test. Test the instrument at the factory to assure proper function operation.

1.04 SUBMITTALS

- A. Provide submittals in accordance with the Specifications.

1.05 JOB CONDITIONS

- A. Environmental Requirements. The equipment shall operate in ambient temperature 0-130°F, relative humidity 0-100%.
- B. Project power 120 volts, 60 hertz single-phase. Appropriate isolation shall be provided.
- C. Standard Signal:
 - 1. Output Signal. Each instrument, which outputs a signal, shall output the standard 4-20 mA signal. The signal shall be constant over a load range of 0 to 600 ohms.
 - 2. Input Signal.
 - a. Electronic devices, such as controllers, match function devices etc., shall have an input impedance of one mega-ohm minimum for an input signal of 1 to 5 VDC.

- b. The 1 to 5 VDC signal shall be developed by the standard 4 to 20 mA transmitted signal through a precision 250 ohm, one-watt resistor.
- c. These requirements allow several receiving units to monitor the same transmitting unit without causing any perturbation of the received signal.
- d. Receiving devices shall not be wired in parallel

PART 2 - PRODUCTS

2.01 EQUIPMENT FURNISHED

- A. Pressure Transmitters: Rosemount 3051TG with Profibus PA communications protocol
- B. Chlorine Analyzers: Prominent Dulcometer DMTa with Profibus DP communications protocol

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Install control panel and all associated control devices. Coordinate exact locations with Owner's Representative as shown on the Drawings.
 - 2. Install instruments in various locations in the field and on panels. Coordinate exact locations with Owner's Representative.
 - 3. Coordinate outages and shutdowns with Owner's representative.
 - 4. Starting or stopping of any existing pump; opening any existing breaker, or disconnecting any instrument; shall be approved in advance through the Owner's Representative
 - 5. All installations shall be in accordance with the Manufacturer's recommendations and instructions.
 - 6. All the necessary mounting accessories shall be provided.

END OF SECTION

SECTION 13422

INSTRUMENTATION ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Description: Provide field instrumentation accessories to complete installation of sensors, meters, switches, transmitters and similar devices.
 - 1. Each installation includes:
 - a. Device.
 - b. Mounting stand where required.
 - c. Process leads, connectors, valves, support means and all other devices and material required for a complete installation.

1.02 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Instrumentation & Control (SCADA) per project site.

1.03 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ANSI/IEEE C37-90-1.
 - 2. API RP550.
 - 3. ANSI/ASTM 153.
 - 4. ANSI/ASTM B 62.
- B. Factory Testing:
 - 1. Subject each device to a complete functional test.
 - 2. Wet flow calibrate flow meters to within specified accuracy.
 - 3. Submit a certified calibration report for each meter showing results of calibration at a minimum of five points evenly spaced throughout range.
 - 4. Apply a Surge Withstand Capability test wave:
 - a. As defined in ANSI/IEEE C37.90-1, to each power supply circuit, battery circuit, signal circuit, output circuit and input circuit.
 - b. Application of test wave shall be as described in Section 4 of ANSI C37.90-1.
 - c. Submit a certified copy of test showing the no load test waveform, details of test wave generator circuit and description of test conducted.

1.04 SUBMITTALS

A. Product Data:

Submit vendor specification information along with a corrected copy of applicable specification form for each device specified in this section.

PRODUCTS

2.01 UNSCHEDULED DEVICES

A. Hand Valves: Provide process valves at all process taps for isolation of instrumentation equipment except where safety would be compromised by their use.

1. General: Valves must provide straight-through passage and tight shutoff to the rating of the valve.
2. Water service with fluid pressure below 200 psig and fluid temperature below 300 F:
 - a. Provide 3/4-inch ball valve with stainless steel swage lock body, disc, union bonnet, and TFE impregnated non-asbestos packing.
 - b. Acceptable manufacturers: Crane No. 431 UB or equal.

B. Pulsation Damper:

1. Provide pulsation dampers where gauges are subject to pulsations and where indicated.
2. Provide damping by means of self-cleaning pin or piston.
3. Make provisions to vary amount of damping while preventing accidental shutoff.

C. Receiver Gauges:

1. Calibrate scale in process units with tick marks for milliamper input in engineering units.
2. Provide diode to maintain loop continuity in case of meter movement failure.
3. Accuracy shall be as specified for panel meters.

D. Mounting Brackets:

1. 2 5/8-inch channel section.
2. 316 Stainless steel.
3. Acceptable Manufacturers:
 - a. Unistrut.
 - b. Or equal.

E.

E. Nameplate:

1. Provide each device with a nameplate identifying tag number and service as specified on device specification form.
2. Make nameplates of 1/6-inch stainless steel.
3. Machine print each nameplate inscription as shown with letters clearly readable from a distance of four feet directly in front of nameplate.
4. Attach nameplates using a minimum of two self-tapping stainless steel sheet metal screws or six-inch length of stainless steel link chain.
5. Name list must be approved by the Owner's Representative before nameplate engraving.
6. External Power Supply: Provide an internal or external on-off switch for each instrument requiring power from an external power source.

F. Surge Protection:

1. Provide surge protection on all 4-20 mA inputs to all analog devices.
2. The surge protection device shall protect field instrumentation from impulses up to 500V or 10,000A induced by lighting strikes or heavy electrical equipment.

The protection device shall be NEMA 4X and installed in accordance with manufacturer's recommendations.

EXECUTION

3.01 PREPARATION

- A. Coordination: Coordinate equipment delivery with completion of other work to minimize field handling of each device.
- B. Verify dimensions in field prior to fabrication.

3.02 INSTALLATION

- A. Mount pipe, and connect field devices in accordance with contract drawings, specification and manufacturer's installation instructions.
- B. Avoid tubing, piping and conduit interferences.
- C. Locate equipment to be accessible for operation, maintenance and replacement.
- D. Examine contract drawings and shop drawings for equipment in order to determine best arrangement for work as a whole.

- E. Mount field transmitters 40 inches above floor, work platform, or as sensing line slope requires per manufacturer's guideline. Coordinate tap location and meter location with Owner's Representative prior to beginning work.
- F. Where specifications and contract drawings do not delineate precise installation procedures, use API RP550 as a guide to installation procedures. Submit sketch for the OWNER's approval prior to installation.
- G. Where field devices are shown as yoke mounted on a floor stand, a wall bracket fabricated from two channel sections 1- 5/8 inches mounted to a wall or column is considered equal.
- H. Make channel section long enough to mount at least two field devices.
- I. Use 316 stainless steel for fabrication.
- J. Locate instrument-mounting stands within five feet of primary element, unless otherwise indicated. Make stands freely accessible.
- K. Locate indicating instruments which must be visible for automatic control adjustment or manual operation to be visible from the adjustment or operating point. If plot or piping arrangement precludes this, make other provisions for indication at the adjustment or operation point.
- L. Install instrument mounting stands after all conduit and pipe have been installed, except conduit serving devices on stand.
- M. Install instrument process piping and tubing from each primary shutoff valve to appropriate gauge, sensor, meter, analyzer, control panel connections, etc.
- N. Clean piping, tubing and components thereof prior to installation. This shall include but is not limited to special cleaning procedures for oxygen service when so required.
- O. Adjust pulsation dampers to eliminate rapid fluctuations of gauge or switch but to retain sensitivity to pressure changes.

3.03 SUPPORT OF FIELD MOUNTED INSTRUMENTS

- A. Locate field-mounted instruments as shown on drawings or as designated by the Owner's representative.
- B. Secure support pipes, stands or brackets of material with sufficient strength to prevent excess vibration or movement.
- C. Locate all transmitters, unless otherwise specified on instrument piping drawings, 40 inches above floor, platform, or as sensing line slope requires per

manufacturer's guidance, in a location to allow convenient access for readability, calibration and maintenance.

END OF SECTION

SECTION 13440

INPUT/OUTPUT LIST

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide and install the required hardware to monitor and control the input/output subsystem. Utilize the existing input/output list from the City. The City will determine the points required for this system.

1.02 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Instrumentation & Control (SCADA) per project site.

1.03 SUBMITTALS

- A. Submit an updated Input/Output list in Excel format, that includes PLC panel number, card and point location, configuration information, point description, point function and tag name for each new point.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The updated Input/Output list shall contain all items to be configuration items of the point and shall be capable of being imported and exported into the system via an Excel spread sheet.

PART 3 - EXECUTION

2.02 INPUT/OUTPUT LISTS

- A. Coordinate final input/output list with the Owner's representative.

END OF SECTION

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SECTION 13445

SCADA SOFTWARE ENGINEERING
QUALITY REQUIREMENTS

PART 1: GENERAL

1.01 Purpose:

A. The purpose of this document is the communication of the requirements of the software used for the control and monitoring of the water treatment facilities. These requirements are intended to address three related areas: 1) SCADA Homeland Security Requirements, 2) Texas Engineering Practice Act, 3) COH Water SCADA quality requirements:

1. According to the National Strategy for Homeland Security water treatment facilities are part of the nation’s critical infrastructure and the government agencies that are responsible shall take specific steps to improve SCADA security.
 - a. Government agencies are required to “Establish policies to minimize the likelihood that organizational personnel will inadvertently disclose sensitive information regarding SCADA system design, operations, or security controls” and “Release data related to the SCADA network only on a strict, need-to-know basis, and only to persons explicitly authorized to receive such information”.
 - b. In compliance with these Homeland Security requirements all SCADA related information is restricted to authorized personnel.
2. In compliance with Texas Engineering Practice Act (Article 3271a) and the recognition that SCADA software is an integral part of the electrical control of the water facilities and is therefore within the jurisdiction of the act:
 - a. All SCADA software related work shall be performed by a licensed engineering firm meeting the qualifications as specified in these requirements and referred to within as the Software Engineer (SE). The software produced for the project shall be stamped by SE in accordance with (Article 3271a §137.33 Sealing Procedures for engineering software).

13445-1

(90% Submittal - 07/18/2016)

3. Additional purposes of these requirements are to refine and perpetuate software engineering and software quality standards that will benefit the Water Operation Branch in the areas of facility operations and facility construction projects:
 - a. The requirements are intended to benefit facility operations through encouraging SCADA standards of consistency in facility functionality and operation, improved process visibility, improved efficiency and control, lower operating costs and reduced risk of permit violations. The SCADA standardization also addresses improved technical support.
 - b. These requirements are intended to minimize SCADA construction related issues by specifying SCADA related construction related deliverables and qualifications that will help ensure the availability and quality of SCADA system integration.
 - c. SCADA related software integration activities have been identified as a key point of quality control for construction projects. The SE shall subcontract directly to the general contractor and shall perform an independent assessment of the SCADA related work of the other subcontractors and equipment suppliers to ensure complete system and software integration within the facility per the construction specification and water SCADA design guidelines.

PART 2: SCOPE:

- 2.01 The requirements defined in this document apply to water facility SCADA software including system control, monitoring and integration. The scope includes new and existing facility construction projects where new SCADA software is required or existing SCADA software is modified. Contractor shall be responsible for all programming.
 - A. SCADA software activities shall be performed only by the pre-approved SE and include: PLC programming, HMI configuration and graphics programming, historical logging software, network configuration and programming.
 - B. Manufactured packaged subsystems with pre-engineered software may be specifically excluded if specified in that subsystem equipment specification, that the system shall be shipped with the software as a fully functional unit. The system PLC application and HMI software shall meet the requirements for SCADA integration and software documentation. The packaged system provider shall deliver all software to SE as soon as possible for the purpose of

review and integration.

- C. These requirements apply to all SCADA security related activities including configuration of servers, workstations and network equipment.
- D. Update the HMI at the City's primary and backup operations centers.

PART 3: Software Engineering Requirements

- 3.01 The SE shall perform the software engineering functions as required within the scope section meeting the requirements within.
 - A. The SE shall use the water standards based on existing applications for SCADA software engineering and Homeland Security in all work performed.
 - 1. The SE shall identify and communicate omissions and suggested improvement to these standards.
 - 2. The existing SCADA software applications and standards are restricted to authorized personnel only according to the Homeland Security requirements. The pre-approved SE is authorized for access to these standards.
- 3.02 The SE will assign a licensed project engineer that personally meets the qualifications in PART-5 SOFTWARE ENGINEERING QUALIFICATIONS to perform and supervise all software engineering activities.
- 3.03 The SE shall provide the SCADA related submittals as defined in the submittals section.
 - A. The SE shall perform the work required to complete the required SCADA software submittals.
 - B. The SE shall review and report on the SCADA related submittals of the project subcontractors and equipment providers.
- 3.04 The SE shall assist the project team including; the engineer, the water operations and equipment suppliers with the SCADA integration issues.
 - A. The SE shall attend project meetings as required by the project team.
 - B. The SE shall assist the project team with functional test of the system.

1. This may include providing project related process data from the SCADA system.

PART 4: SUBMITTALS:

- 4.01 Within 10 days of the notice to proceed the SE shall submit a letter of SE qualifications specifically addressing each item of qualification as defined in these requirements.
 - A. Include the SE professional engineering firm licensed number and date of issuance.
 - B. Include the SE assigned software engineering project engineer name, licensed number and date of issuance.
 - C. Include a statement addressing the awareness of the Homeland Security concerns and intention to restrict the dissemination of security sensitive SCADA network information to those who are authorized by the COH and require the information in the support of this project.
- 4.02 Within 30 days of the notice to proceed the SE will conduct a workshop with the City's DWO and SCADA staff to discuss the project's PLC and HMI software requirements.
- 4.03 Within 90 days of the notice to proceed the SE will submit the Software Engineering Manual (Preliminary Report)
 - A. Include the software conventions for the use in the HMI development.
 - B. Include diagrams and schedules for all network devices associated with the process control and monitoring for the facility/facilities.
 - C. Include the interfaces for the City SCADA network.
 - D. Identify every network component (new and existing).
 - E. The Software Engineering Manual will be updated for the final O&M.
 - F. Conduct a review meeting with the City's DWO and SCADA staff seven days following the delivery of the Preliminary Report. Schedule this meeting with the City at the time of submission of the Preliminary Report.
- 4.04 The SE will submit letters of software and network integration compatibility to be included in the all control related submittals.
 - A. Included but not limited to: PLCs, network devices, computers, HMI devices

- B. Include deviations from City standards and the construction specifications for electrical control drawings and tag naming conventions.
 - C. Include deviations from the submitted Software Engineering Preliminary Report.
 - D. Include the manufacturer supplied package systems with control panels.
 - E. The SE shall distribute monthly a Software Engineering Integration Schedule highlighting software and system integration progress and issues.
- 4.05 Factory demonstration test confirmation report
- A. After the required factory demonstration test the SE will submit a test report confirming the related software and network compatibility.
- 4.06 Field Acceptance Functional Test
- A. Shall be completed prior to performance and reliability testing.
 - B. Field Acceptance Functional Test Submittals shall include:
 - 1. Field Acceptance Functional Test Plan Submittal,
 - 2. Description of plan for testing field devices,
 - 3. Description of plan for function test and system integration of each subsystem,
 - 4. Field Acceptance Functional Test Schedule shall be submitted after the acceptance of the test plan submittal,
 - 5. Field Acceptance Functional Test plan completion report shall be submitted.
- 4.07 Updated Software Engineering Manual (Final Version)
- A. Update and submit a singled CD with all related SCADA software.
 - B. Control and network components
 - C. Inventory of software components

- D. Network device configuration documentation
- E. Software Engineering documentation
- F. PLC and HMI software shall be documented using the product development tool.
- G. Software shall be stamped as required in Texas Engineering Practice Act (Article 3271a §137.33 Sealing Procedures) with the date, the engineers name, the PE designation with license number.
- H. The SE will collect and submit all software and network device configuration programs and data developed for the project.

PART 5: SOFTWARE ENGINEER (SE) QUALIFICATIONS

- 5.01 Qualifications for performing all SCADA related software activities for the water facilities as defined in these requirements.
- 5.02 The SE shall be pre-approved by the engineer and the owner no later than seven (7) days prior to the project bid opening date for construction projects.
- 5.03 Specific qualifications for pre-approved SE:
 - A. The SE shall be a Texas Registered Professional Engineering firm with a minimum of 5 years of licensed history. Software Engineering, Control Systems Engineering, or Electrical Engineering licenses are preferred. Experience with water treatment and production facilities is required.
 - B. The SE shall be experienced with the existing COH SCADA software application and the development packages which are used as standards for Water Operations including a minimum 5 years of licensed software engineering experience with G.E. IFIX HMI and Siemens Step-7 development packages.
 - C. The SE shall demonstrate a minimum of 3 years of continuous Cisco Advanced Security expertise with Cisco staff certifications. This ensures the SE has the required expertise to configure, secure and maintain the SCADA system network.
 - D. The SE shall have errors and omissions insurance with coverage in the amount of \$1,000,000 (aggregate).
 - E. The SE shall have an existing office, within the City of Houston, and shall

**SCADA SOFTWARE ENGINEERING AND QUALITY
REQUIREMENTS**

maintain that office for the duration of the warranty and extended software service requirement.

F. To ensure effectiveness and objectivity in the review and reporting of SCADA related integration issues the SE shall be an independent entity and provide only software engineering services for the construction project.

G. Software Engineering firms to include:

1. Automation Nation, Inc.
2. CDM Smith
3. CH2M-Hill
4. Or approved equal.

END OF SECTION

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SECTION 15047

METERING PRESSURE REDUCING VALVE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metering Pressure Reducing Valves (MPRV).

1.02 MEASUREMENT AND PAYMENT

- A. Payment for design, manufacture and installation of new metering pressure reducing valves in the discharge piping shall be included in the unit bid price bid per valve at indicated size.

1.03 RELATED SECTIONS

- A. Section 01330 – Submittal Procedures
- B. Section 01600 – Materials and Equipment
- C. Section 01655 – Starting of Systems
- D. Section 01800 – Operations and Maintenance Data
- E. Division 13000, Instrumentation and Control Sections
- F. Division 16000, Electrical

1.04 REFERENCES

- A. ASME B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings.
- B. ASTM B16.24 - Cast Copper Alloy Pipe

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Valve Manufacturer Submittals: Submit for review detailed drawings, data and descriptive literature on all valves and appurtenances, including:
 - 1. Dimensions.

2. Size.
 3. Materials of construction.
 4. Weight.
 5. Protective coating.
- C. Manufacturer's Certifications: Submit manufacturer's certificates of compliance with ANSI, ASME and other Standards listed herein.

1.06 QUALITY CONTROL

- A. Valves and appurtenances provided under this section shall be by manufacturers whose products have been proven reliable in similar service for at least five (5) years.
- B. Manufacturer shall hydrostatically test valve in the factory to confirm adjustment setting ranges and proper operation.

PART 2 PRODUCTS

2.1 METERING PRESSURE REDUCING VALVE

- A. Valves shall open or close based on a control signal from SCADA system to local manufacturers supplied valve controller. Valve shall be capable of receiving a input flow rate signal, tank level, or upstream and downstream pressure setpoint for valve operation. Provision shall be incorporated to regulate the closing speed of the valve and initially set by manufacturer to close/open in approximately three minutes. Valve shall be capable of operating with pressures between 100 – 2 psi and and pressure tested to 150 psi.
- B. Provide flow metering with PRV so that calculated flow is within 2% accuracy of actual flow. Metering can be performed with position control indication along with pressure differential, or with single point insertion type magnetic flow meter, or other type based upon manufacturer's requirements. Manufacturers control shall receive information, as required, from the valve and provide an output 4-20 mA signal for SCADA system. A local controller shall have its own program for required PID control and be capable of displaying operational parameter locally along with flow through the valve.
- C. Valve controller shall provide all necessary power and controls for valve appurtenances for proper operation and metering. Controller shall operate off of a local 120 V power source. Controller shall be capable of receiving and sending up to four 4-20 mA analog inputs and outputs, as well as, four digital dry contacts for SCADA use. Controller shall be able to operate valve by maintaining a flow through the valve, or an upstream or downstream pressure setpoint.

- D. The valve shall be capable of operating in horizontal position and shall incorporate only one flanged cover at the valve top from which all internal parts shall be accessible. The valve shall be furnished in a globe design to suit project conditions.
- E. All controls and piping shall be noncorrosive construction materials.
- F. A visual valve position indicator shall be provided for observing the valve position.

2.2 MATERIALS

- A. Provide approved Metering Pressure Reducing Valve in location and arrangement as shown on Drawings.
 - 1. Valve body and cover: Ductile iron with ASME B16.42, Grade ASTM A536, Class 150, flanges.
 - 2. Valve internals:
 - a. Provide top and bottom single moving disc and diaphragm assembly.
 - b. Provide anti-cavitation trim.
 - c. Use flexible nylon fabric reinforced elastomer diaphragm integral with assembly.
 - d. Disc shall be Buna-N Rubber.
 - e. Provide valve internal trim (seat ring, disc guide, and cover bearing) made of stainless steel.
 - f. Provide heat fusion bonded epoxy NFS61coating (14 mils minimum) to internal and external surfaces of valve body including disc retainer and diaphragm washer. Holiday test coating applied to valve body.
- B. Control Tubing: Contain shutoff cocks with Y-strainer.
- C. All components/materials in contact with water shall be NSF 61 approved for potable drinking water.

2.3 ACCEPTABLE MANUFACTURERS

- A. CLA-VAL
- B. Singer Valve

PART 3 EXECUTION

3.1 SETTING VALVES

- A. Provide services of technical representative of valve manufacturer on site during installation of valves and to serve as adviser on aspects of installation. Take necessary precautions to protect pilot system during PRV installation.
- B. Prior to installing valves, remove foreign matter from within valves. Inspect valves in open and closed position to verify that parts are in satisfactory working condition.
- C. Manufacturer shall confirm that valve operation through supplied local controller is fully functional and work together with SCADA contractor that all aspects of valve control and flow metering meet specifications.

END OF SECTION

SECTION 15138

ELECTRIC VALVE ACTUATORS

PART 1 - G E N E R A L

1.01 SUMMARY

- A. The Contractor shall provide all electric valve actuators and appurtenances, complete and operable, in accordance with the drawings and specifications.
- B. The provisions of this section shall apply to all valves, except where otherwise indicated in the drawings and specifications.
- C. Unit Responsibility: A single manufacturer shall be made responsible for furnishing the work and for coordination of design, assembly, testing, and installation of the work of each type of valve. However, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve section. Unless otherwise indicated, the single manufacturer shall be the manufacturer of the valve.
- D. Single Manufacturer: Where two or more valve actuators of the same type or size are required, the same manufacturer shall produce all actuators.

1.02 MEASUREMENT AND PAYMENT

- A. Payment for design, manufacture and installation of electric actuator shall be included in cost of the specific type of valve “with electric valve actuator” noted in Bid Form.

1.03 SUBMITTALS

- A. General: Submittals shall be furnished in accordance with Section 01330 – Submittals.
- B. Shop Drawings: Shop Drawings for all actuators shall be submitted together with the valve submittals as a complete package.

1.04 QUALITY ASSURANCE

- A. All valve actuator manufacturers shall have at least five years of experience manufacturing actuators similar to those supplied for this work.

PART 2 - P R O D U C T S

2.01 GENERAL

A. General:

1. Where indicated on the drawings, provide electrical actuated valves power actuators. The Contractor shall furnish all actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, handwheels, levers, chains, and extensions, as applicable. All actuators shall be capable of holding the valve in any intermediate position between fully open and fully closed without creeping or fluttering. All wires of motor-driven actuators shall be identified by unique numbers.

B. Manufacturers:

1. Where indicated, certain valves may be provided with actuators manufactured by the valve manufacturer. Where actuators are furnished by different manufacturers, the Contractor shall coordinate selection to have the fewest number of manufacturers possible.

C. Materials:

1. All actuators shall be current models of the best commercial quality materials and liberally-sized for the maximum expected torque. All materials shall be suitable for the environment in which the valve is to be installed.

D. Mounting:

1. All actuators shall be securely mounted by means of brackets or hardware specially designed and sized for this purpose and of ample strength. The word "open" shall be cast on each valve or actuator with an arrow indicating the direction to open in the counter-clockwise direction. All electric actuators shall be equipped with position indicators. Where possible, electric actuators shall be located between 48 and 60 inches above the floor or platform.

E. Standard:

1. Unless otherwise indicated and where applicable, all actuators shall be in accordance with ANSI/AWWA C 540 - AWWA Standard for Power-Actuating Devices for Valves and Sluice Gates.

F. Functionality:

1. Electric actuators shall be coordinated with power and instrumentation equipment indicated elsewhere in the drawings and specifications.

2.02 ELECTRIC MOTOR ACTUATORS

A. General:

1. Where electric motor actuators are indicated, an electric motor-actuated valve control unit shall be attached to the actuating mechanism housing by means of a flanged motor adaptor piece.

B. Gearing:

1. The motor actuator shall include the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly. The actuator shall be a single or double reduction unit consisting of spur or helical gears and worm-gearing. The spur or helical gears shall be of hardened alloy steel and the worm-gear shall be alloy bronze. All gearing shall be accurately cut with hobbing machines. All power gearing shall be grease- or oil-lubricated in a sealed housing. Ball or roller bearings shall be used throughout. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the electric actuator. Use of pulsing relays, timing relays or solid-state controls to achieve specified or indicated speed is not acceptable.

C. Starting Device:

1. Except for modulating valves, the unit shall be so designed that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve. The device should allow free movement at the stem nut before imparting the hammer blow. The actuator motor must attain full speed before stem load is encountered.

D. Switches and Wiring:

1. Travel in the opening and closing directions shall be governed by a switch responsive to mechanical torque developed in seating the valve, or by an obstruction met in opening or closing the valve, or by an on-board microprocessor. The torque switch shall be adjustable and shall function without auxiliary relays or devices, or it shall be adjustable in one-percent increments, sensed by a pulse-counter, which receives 15 pulses per rotation of the unit. The geared limit switches shall be of the open type and shall be actuated by a rotor cam with 4 contacts to each cam or gear train. The actuator shall have a number of gear trains as required to produce the operation indicated. The actuator shall be wired in accordance with the schematic diagram. All wiring for external connections shall be connected to marked terminals. One 1-inch and one 1-1/4-inch conduit connection shall be provided in the enclosing case. A calibration tag shall be mounted near each switch correlating the dial

setting to the unit output torque. Position limit switches and associated gearing shall be an integral part of the valve actuator. To provide the best possible accuracy and repeatability, limit-switch gearing shall be of the "counting" intermittent type, made of stainless steel, grease-lubricated, and enclosed in its own gearcase to prevent dirt and foreign matter from entering the gear train. Switches shall not be subject to breakage or slippage due to over-travel. Traveling-nuts, cams, or microswitch tripping mechanisms shall not be used. Limit-switches shall be of the heavy-duty open contact type with rotary wiping action.

E. Handwheel Operation:

1. A permanently-attached handwheel shall be provided for emergency manual operation. The handwheel shall not rotate during electrical operation. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb. An arrow and either the word "open" or "close" shall be cast or permanently affixed on the handwheel to indicate the appropriate direction to turn the handwheel.

F. Motor:

1. The motor shall be of the totally-enclosed, non-ventilated, high-starting torque, low-starting current type for full voltage starting. It shall be suitable for operation on 208-volt, 3-phase, 60-Hz current, and have Class F insulation and a motor frame with all dimensions in accordance with the latest revised NEMA MG Standards. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C when operating continuously for 15 minutes under full rated load. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop-out. All bearings shall be of the ball type and thrust bearings shall be provided where necessary. All bearings shall be provided with suitable seals to confine the lubricant and prevent the entrance of dirt and dust. Motor conduit connections shall be watertight. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement. The motor shall be furnished with a space heater suitable for operation on 120-volt, single-phase, 60-Hz circuit unless the entire actuator is an hermetically-sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion.

G. Electric Motor Actuators (AC Reversing Control Type):

1. General: Where indicated, electric motor actuators shall be the AC reversing type complete with local control station with open/close and local/remote selector switches.
2. Actuator Appurtenances: The actuator for each valve shall be supplied with open and close status lights; open, close and lock-out-stop push-buttons, and all other devices indicated.
3. Starter: The starter shall be suitably sized amperage rated reversing starter with its coils rated for operation on 120/208-volt, 1-phase, 60-Hz current. A control power transformer shall be included to provide a 120-volt source, unless otherwise indicated. The starter shall be equipped with 3 overload relays of the automatic reset-type. Its control circuit shall be wired as indicated. The integral weatherproof compartment shall contain a suitably sized 120-volt ac, single-phase, 60-Hz space heater to prevent moisture condensation on electrical components. Provide a thermal magnetic circuit breaker in NEMA 4 enclosure if not part of the integral valve package.
4. Manufacturers, or equal
 - a. Bernard Controls

PART 3 - EXECUTION

3.01 SERVICES OF MANUFACTURER

- A. Field Adjustments: Field representatives of manufacturers of valves with electric actuators shall adjust actuator controls and limit-switches in the field for the required function.

3.02 INSTALLATION

- A. All valve actuators and accessories shall be installed in accordance with manufacturer's installation instructions. Actuators shall be located to be readily accessible for operation and maintenance, without obstructing walkways. Actuators shall not be mounted where shock or vibrations will impair their operation, nor shall the support systems be attached to handrails, process piping, or mechanical equipment.

3.03 ACCEPTANCE TEST

- A. Upon completion of the installation of each valve actuator, an acceptance test will be conducted to verify the satisfactory operation and performance of each actuator. Each valve shall be opened and closed in auto mode and manually.

The test shall be conducted in a manner approved by and in the presence of the Engineer.

- B. Each valve actuator must perform in a manner acceptable to the Engineer before final acceptance will be made by the Owner.

END OF SECTION

Section 16050
ELECTRICAL GENERAL PROVISIONS

PART 1 - G E N E R A L

1.01 SUMMARY

Provide labor, materials and equipment testing and troubleshooting required for complete and functioning electrical systems as required by the contract documents.

A. New Work. The work includes, but is not limited to, the following principal systems and equipment:

1. 480 volt distribution.
2. 208/120 volt distribution.
3. Raceway systems for communication system cables.
4. Panelboards.
5. Transformers.

1.02 MEASUREMENT AND PAYMENT

A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.03 APPLICABLE PROVISIONS

A. Provisions Specified Elsewhere. Unless modified in this section, General and Supplementary General Conditions, applicable provisions of Division 1 - General and other provisions of contract documents apply to work of Division 16 - Electrical.

B. Application. Provisions of this section apply to every section of Division 16 - Electrical, except where specifically modified.

1.04 REFERENCE CODES AND STANDARDS

Standards of the following organizations may be referenced in the specification. Unless noted otherwise, references are to standards or codes current at the time of bidding.

- A. Association of Edison Illuminating Companies (AEIC).
- B. American National Standards Institute (ANSI).
- C. Institute of Electrical and Electronics Engineers (IEEE).
- D. Insulated Cable Engineers Association (ICEA).
- E. National Electrical Code (NEC).

- F. National Electrical Contractors Association (NECA).
- G. National Electrical Manufacturers Association (NEMA).
- H. National Electrical Safety Code (NESC).
- I. National Electrical Testing Association (NETA).
- J. National Fire Protection Association (NFPA).
- K. Underwriters' Laboratories (UL).

1.05 REGULATIONS AND PERMITS

- A. Regulations. Work, materials and equipment must comply with the latest rules and regulations of the following:
 - 1. National Electrical Code (NEC).
 - 2. National Electrical Safety Code (NESC).
 - 3. Occupational Safety and Health Act (OSHA).
 - 4. Americans with Disabilities Act (ADA).
 - 5. Local, state and federal codes, ordinances and regulations.
- B. Discrepancies. The drawings and specifications are intended to comply with listed codes, ordinances, regulations and standards. Where discrepancies occur, immediately notify the Owner's representative in writing and ask for an interpretation. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirements, provide those specified or shown.
- C. Permits. Obtain certificates of inspection and other permits required as a part of the work.

1.06 CONTRACT DRAWINGS

- A. Intent. The intent of the drawings is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system. Electrical drawings are generally diagrammatic and show approximate location and extent of work. Install the work complete, including minor details necessary to perform the function indicated. In case of doubt as to work intended, or if amplification or clarification is needed, request instructions from the Owner's representative.
- B. Discrepancies. Review pertinent drawings and adjust the work to conditions shown. Where discrepancies occur between drawings, specifications, and actual field conditions, immediately notify the Owner's representative for his interpretation.

- C. Outlet and Equipment Locations. Coordinate the actual locations of electrical outlets and equipment with building features and equipment as indicated on architectural, structural, mechanical and plumbing drawings. Review with the Owner's representative any proposed changes in outlet or equipment location. Relocation of outlets before installation, of up to 5 feet from the position indicated, may be directed without additional cost. Remove and relocate outlets placed in an unsuitable location, when so requested by the Owner's representative.

1.07 CONTRACTOR QUALIFICATIONS

An acceptable Contractor for the work under this division must have personnel with experience, training and skill to provide a practical working system. The Contractor may be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project. The systems must have served satisfactorily for not less than 3 years. The superintendent must have had experience in installing not less than three such systems.

PART 2 - P R O D U C T S

2.01 PRODUCT REQUIREMENTS

- A. Condition. Provide new products of manufacturers regularly engaged in production of such equipment. Provide the manufacturer's latest standard design for the type of product specified.
- B. NEC and UL. Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products and issued labels, products used must be listed and labeled by UL.
- C. Space Limitations. Equipment selected must conform to the building features and must be coordinated with them. Do not provide equipment which will not suit arrangement and space limitations.
- D. Factory Finish. Equipment must be delivered with a hard surface, factory-applied finish so that no additional field painting is required except for touch-up as required.

2.02 SUBSTITUTIONS

Refer to Section 01600, Product Requirements.

PART 3 - EXECUTION

3.01 PROTECTION OF EQUIPMENT

- A. Moisture. During construction, protect transformers, motors, control equipment, and other items from insulation moisture absorption and metallic component corrosion by appropriate use of strip heaters, lamps or other suitable means. Apply protection immediately on receiving the products and maintain continually.
- B. Clean. Keep products clean by elevating above ground or floor and by using suitable coverings.
- C. Damage. Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.
- D. Finish. Protect factory finish from damage during construction operations and until acceptance of the project. Satisfactorily restore any finishes that become stained or damaged.

3.02 INSTALLATION

- A. Cooperation with Other Trades. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades.
- B. Workmanship. Work must be performed by workmen skilled in their trade. The installation must be complete. Provide work in accordance with NECA 1.
- C. Concrete Equipment Pads. Install 3-1/2-inch-thick concrete foundation pads for indoor floor-mounted equipment, except where direct floor mounting is required. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3 inches beyond equipment. Trowel pads smooth and chamfer edges to a 1-inch bevel. Secure equipment to pads as recommended by the manufacturer.
- D. Setting of Equipment. Equipment must be leveled and set plumb. Sheet metal enclosures mounted against a wall must be separated from the wall not less than 1/4 inch by means of corrosion-resistant spacers or by 3 inches of air for freestanding units. Use corrosion-resistant bolts, nuts and washers to anchor equipment. In sufficient time to be coordinated with work under other divisions, provide drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.
- E. Application. Unless otherwise indicated, power will be utilized as follows:

1. 208 volts, three phase for motor operated valves.

F. Transformers. Use transformers to change the service to the required utilization voltages.

3.03 TESTING

A. Test Conditions. Place circuits and equipment into service under normal conditions, collectively and separately, as may be necessary to determine satisfactory operation. Perform specified tests in the presence of the Owner's representative. Furnish all instruments, wiring, equipment and personnel required for conducting tests. Demonstrate that the equipment operates in accordance with requirements of the drawings and specifications. Special tests on certain items are specified hereinafter. Where specified that the testing be performed by an independent testing company, an Owner approved NETA certified testing company shall be used.

B. Test Dates. Schedule final acceptance tests sufficiently in advance of the contract date to permit completion of any necessary adjustment or alterations within the number of days allotted for completion of the contract.

C. Retests. Conduct retests as directed by the Owner's representative of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Any resultant delay as a result of such necessary retests does not relieve the Contractor of his responsibility under this contract.

END OF SECTION

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SECTION 16051

ACCEPTANCE TESTING AND CALIBRATION

PART 1 - GENERAL

1.01 SUMMARY

This section provides the guidelines for testing of electrical equipment, low voltage cable, circuit breakers, motors, and related apparatus to be used for the site interior and exterior electrical distribution system. This specification does not release the CONTRACTOR or vendor from any further testing required for safe commissioning of the equipment.

1.01 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.02 RELATED WORK AND SPECIFICATIONS

- A. Submittals. Section 01330.
- B. Material and Equipment. Section 01600.
- C. Operation and Maintenance Data. Section 01800.

1.03 QUALITY ASSURANCE

National Electric Testing Association Standards for acceptance testing of Electrical Distribution Apparatus, Publication 2.001, and IEEE Publication No. 141, are hereby made a part of this section, unless otherwise modified herein.

1.04 TESTS

- A. All tests, other than Low Voltage Systems and Equipment, will be supervised by the OWNER. THE CONTRACTOR will give a one-week notice of all scheduled tests to the OWNER in writing. If a third party is conducting the tests, the CONTRACTOR's presence will be required also.
- B. Provide tests as required by specific sections of these Division 16 specifications. Review Division 16 requirements for other testing not specifically mention in this section.
- C. Under this specification the CONTRACTOR shall perform the electrical tests on the following equipment and as specified under Part 3, Execution. The

CONTRACTOR will supply all equipment required to perform all testing responsibilities.

1. All transformers.
2. Low voltage cable.
3. Motors.
4. All controls for miscellaneous motors.
5. Grounding.

- D. The Contractor will notify the Owner of scheduled dates of electrical equipment installation completion. Equipment testing will be coordinated at this time by Contractor with Owner and appropriate Manufacturer's Representatives.

PART 2 - P R O D U C T S

Not Applicable

PART 3 - E X E C U T I O N

1.01 PREPARATORY WORK

Prior to the testing of any specific piece of equipment, the Contractor will remove all shipping hardware and inspect for broken or missing parts and proper connections in accordance with the manufacturer's instructions.

1.02 GENERAL

Submit directly to the ENGINEER six (6) copies of all test reports certified by the testing technician.

END OF SECTION

11000-B. MANUFACTURER'S INSTRUCTION CERTIFICATION FORM

Contract No.: _____ Specification Section: _____

Equipment Name: _____

Contractor: _____

Manufacturers of an equipment item: _____

The undersigned manufacturer certifies that a service ENGINEER has instructed the wastewater treatment operating personnel in the proper maintenance and operation of the equipment designated herein.

Operations Check List (check appropriate spaces)

Start-up procedure reviewed

Shutdown procedure reviewed

Normal operation procedure reviewed

Others:

Maintenance Check List (check appropriate spaces)

Described normal oil changes (frequency)

Described special tools required

Described normal items to be reviewed for wear

Described preventive maintenance instructions

Described greasing frequency

Others:

Date: _____

Manufacturer: _____

Signature of Authorized Representative

Date: _____

Signature of Owner's Representative

Date: _____

Signature of Contractor's Representative

11000-A. **MANUFACTURER'S INSTALLATION CERTIFICATION FORM**

Contract No.: _____ Specification Section: _____

Equipment Name: _____

Contractor: _____

Manufacturer of equipment item: _____

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: _____

Signature of Authorized Representative: _____

Date: _____ Contractor: _____

Signature of Authorized Representative: _____

TRANSFORMER TEST REPORT

PROJECT NO.: _____					
OWNER: _____					
CONTRACTOR: _____					
ENGINEER: _____					
PROJECT: _____					
REFERENCE DATA:					
Report No. _____ Description: _____					
Specification Section No. _____ Page No. _____ Paragraph No. _____					
Sheet No. _____ Entitled _____					
Detail Designation _____ Drawing Attached (Y/N) _____					
EQUIPMENT IDENTIFICATION:					
Name (From Drawings) _____					
Identification No. _____ Unit No. _____					
Manufacturer _____					
Model No. _____ Serial No. _____					
LOCATION: Structure _____					
N/S Coord. _____ E/W Coord. _____ Station _____ Elev. _____					
RESISTANCE TESTER					
Mfgr. _____ Model No. _____ Serial No. _____					
Range _____ Megohms _____ MaxVoltage _____ vdc					
WEATHER _____ °F _____ % RH DATE _____					
KVA _____ PHASE _____					
PRIMARY VOLTAGE _____ SECONDARY VOLTAGE _____					
Primary Insulation Resistance (Megahoms after 15 sec.)			Secondary Insulation Resistance (Megahoms after 15 sec.)		
Phase A	Phase B	Phase C	Phase A	Phase B	Phase C
Test by: _____			Test by: _____		
Witness by: _____			Witness by: _____		

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SECTION 16052
IDENTIFICATIONS

PART 1 - G E N E R A L

1.01 SUMMARY

Furnish and install tags/nameplates on all equipment, devices, instruments, conduit, and conductor marked as indicated on the drawings and as specified herein. Major equipment shall be furnished with nameplates in accordance with their individual specifications.

1.01 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.02 RELATED WORK AND SPECIFICATIONS

- A. Submittals. Section 01330.
- B. Electrical General Provisions. Section 16050.

PART 2 - P R O D U C T S

2.01 EQUIPMENT AND DEVICE MARKING

- A. Designations. Identify all equipment, devices, feeders, branch circuits and similar items with the same designations as indicated on the contract documents.
- B. Nameplates. Externally mark all electrical equipment with nameplates identifying each and the equipment served. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1 inch high by 3 inches long with 3/16-inch-high engraved white letters. Supply blank nameplates for spare units and spaces.
- C. Nameplate Fasteners. Fasten nameplates to the front of equipment only by means of stainless steel self-taping screws. Stick-ons or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.
- D. Nameplate Information. In general, the following information is to be provided for the types of electrical equipment as listed.
 - 1. Transformers, Individual Starters, Contactors, Disconnect Switches, Transfer Switches and similar equipment. Identify the device designation, source and load served.

2. Panelboards. Identify the source, panelboard designation and voltage characteristics.
- E. Panelboards. Prepare a neatly typed circuit directory behind clear heat-resistant plastic in a metal frame attached to the inside of the door for each panelboard. Identify circuits by equipment served and by room numbers where room numbers exist. Indicate spares and spaces with light, erasable pencil marking. Adhesive mounted directory pocket is not acceptable.
- F. Pull, Junction and Outlet Boxes. With 1/2-inch-high lettering, identify conduits connected to pull, junction and outlet boxes with the complete circuit number of the conductors contained therein. Where multiple circuits are contained in a box, identify the circuit conductors with permanent tags which indicate circuit designation.
- G. Power Receptacles. Use nameplate or engrave device plate to identify power receptacles where the nominal voltage between any pair of contacts is greater than 150 volts with circuit number, voltage and phases. If nameplates are used, attach to wall directly above device plate.

2.02 CONDUCTORS IDENTIFICATION SYSTEM

- A. Provide heat-shrink wire markers, or approved equal, for conductor identification.
- B. Provide complete power and control conductor identification system so that after installation circuits can be easily traced from origin to final destination.
- C. Identify power and control conductors at each termination and in all accessible locations such as manholes, handholes, panels, switchboards, pull boxes, terminal boxes, etc. For identification, use type of tags specified herein.
- D. Tag conductors using a three-segment conductor numbering scheme which defines the origin of the conductor, the function of the conductor, and the destination of the conductor.
- E. Example: MCC-B1-A1-AIR where MCC-B1, Cubicle A1 is the origin.
- F. Make the origin and destination identification the specific names for the equipment used in the Contract Documents.

2.03 CONDUIT MARKERS

Conduit markers shall be the metal type permitting embossing on the job.

2.04 POWER OUTLETS, SWITCHES, AND PILOT DEVICES

- A. Mark power outlets with voltage, phase, and circuit number.

- B. Identify all wall switches, disconnect switches, etc., with name tags and circuits served.
- C. Identify all pushbutton stations with their functions and equipment served.

PART 3 - EXECUTION

3.01 CONDUIT MARKERS

- A. Exposed Conduits.
 - 1. Furnish conduit markers at the point of origin, point of termination upon crossing on each side, and at 50-foot intervals for all exposed and accessible conduits.
 - 2. Install markers lengthwise and attach with cable ties.

3.02 CONDUCTORS

Tag all conductors at their origin, termination, pullboxes and junction boxes.

3.03 NAMEPLATES/TAGS

- A. Furnish and install nameplates for all switchgear, panelboards, motor starters, motor control centers, disconnect switches, instrument panels, dry-type transformers, and control stations.
- B. Engrave the equipment designation, on nameplates. All switches, indicating lights, pushbuttons, meters, and parameter indicators on panels shall be clearly identified with its function or tag, as required.
- C. Stainless steel tags shall be used on instrument, motors, and other devices, as applicable. The tags shall be affixed to the instrument with drive pins or stainless steel wire in such manner that it does not need to be removed to install the instrument. Motors shall carry the tag assigned to its driven equipment, i.e., P-101.

END OF SECTION

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SECTION 16060

ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

1.02 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.03 REFERENCES

- A. Temporary wiring of systems to maintain operation of facilities while undergoing modifications and demolition shall be provided in accordance with:
 - 1. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), No. 70 - National Electrical Code (NEC), Article No. 305 - Temporary Wiring
 - 2. City of Houston Electrical Code.

1.04 SUBMITTALS

- A. Annotate existing drawings to sequence the demolition of systems, equipment removal and temporary hook-ups.
- B. Schedule with Project Manager for required shut-downs to accommodate system demolition and installation of temporary facilities.

1.05 QUALITY ASSURANCE

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents. Report discrepancies to City Engineer before disturbing existing installation.

- D. By beginning demolition, installer accepts existing conditions and warrants that he will maintain service to equipment and items not scheduled or indicated for removal, and that he will return to the City all items and systems in good operating condition.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual Sections.

2.02 DESIGN AND CONSTRUCTION

- A. The temporary electrical wiring and facilities shall be designed and constructed in strict compliance with NEC - Article No. 305 and the City of Houston Electrical Code.

PART 3 EXECUTION

3.01 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Coordinate utility service outages with utility company to provide continuous service to operating equipment.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, notify City of Houston Utility Operations and get approval. Use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the City Engineer at least one week before partially or completely disabling system. Minimize outage duration.
- E. Adding Load to Existing Electrical System: Perform a load analysis to assure that the existing power distribution system (MCC, service, conductors, panel, breakers, feeders, branch circuits, etc.) is not overloaded if additional load is added to existing equipment.
- F. Existing electrical conduit and wire may not be reused to feed new equipment except by written authorization from the City of Houston.

3.02 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Repair adjacent construction and finishes damaged during demolition and extension work.
- H. Maintain access to existing installations which remain active. Modify installation or provide access panel as appropriate.
- I. Extend existing installations using materials and methods as specified for new work.

3.03 DISPOSAL AND SALVAGE

- A. Salvage electrical and instrumentation equipment removed from existing facilities for reuse as applicable.
- B. Material and equipment which can be reused or salvaged remains the property of the City of Houston unless specifically indicated in the Specifications or Drawings or as designated by the City Engineer. Equipment to be retained by the City of Houston shall be delivered to a specified location by the Contractor.
- C. Materials and equipment which cannot be reused or salvaged will be removed and disposed by the Contractor.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates

for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

3.05 INSTALLATION

- B. Electrical installations and materials shall conform to the current issue of the following standard and codes: American National Standards Institute/National Fire Protection Association (ANSI/NFPA), No. 70 - National Electrical Code (NEC), City of Houston Electrical Code, and material and workmanship.
- C. All material shall be free of defects and in safe working condition which will meet electrical classification and functional requirements.
- D. Testing shall be made during the course of construction or at the completion of the job. These tests shall be made by the electrical contractor. The contractor shall furnish all test equipment.
- E. The job will not be complete until work has been inspected and trial start up has been successfully completed.

END OF SECTION

SECTION 16120
INSULATED CONDUCTORS

PART 1 - GENERAL

1.01 SUMMARY

Provide insulated conductors.

1.01 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.02 RELATED WORK AND SPECIFICATIONS

- A. Submittals. Section 01330.
- B. Acceptance Testing and Calibration. Section 16051.
- C. Identifications. Section 16052
- D. Grounding. Section 16060

1.03 REFERENCE STANDARDS

- A. ANSI/UL 83 - Thermoplastic-Insulated Wires and Cables.
- B. ANSI/UL 1277 - Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
- C. ICEA S-61-402 (NEMA WC 5) - Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.04 SUBMITTALS

- A. Provide product data on the following:
 - 1) 600-volt conductor, splicing and terminating materials.

PART 2 - PRODUCTS

2.01 IDENTIFICATION

Provide new insulated conductors marked according to NEC Article 310.

2.02 600-VOLT INSULATED CONDUCTORS

A. Size. As shown.

B. Construction.

- 1) Conductor. Soft-drawn, annealed copper. Stranded for No. 16 AWG and larger.
- 2) Insulation. Unless otherwise noted on the drawings, use THHN/THWN for general wiring and XHHW for exterior wiring.

C. Usage.

- 1) For general wiring use No. 12 minimum.
- 2) For field-installed control wiring use No. 14 or larger stranded conductors.
- 3) For tray cable (Type TC) provide a multi-conductor cable consisting of insulated conductors as described in the preceding paragraph with an overall outer sheath. Use a nonmetallic sheath that is moisture, sunlight and corrosion resistant and flame retardant, specifically approved for this purpose.
- 4) For analog cables provide individually shielded pairs or triads, as required for application, with overall shield and No. 16 or larger standard conductors.

D. Listing.

- 1) Single Conductor. UL 83.
- 2) Tray Cable. UL 1277.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Protection. Unless otherwise indicated, mechanically protect conductors for systems by installing in raceways. Do not install the conductors until raceway system is complete and properly cleaned. Use Polywater J cable lubricant when pulling conductors. Do not bend any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors. Do not exceed manufacturer's recommended values for maximum pulling tension.

B. Splices and Terminations. Use pressure-type lugs or connectors for terminations or splices of all stranded conductors. Use ring-tongue type terminators on all

control wiring. Make grounding (earth) conductor approximately 2 inches longer than the ungrounded (phase) conductors at both ends. Refer to Section 16060.

- C. Appearance. Neatly and securely bundle or cable all conductors in an enclosure using nylon straps with a locking hub or head on one end and a taper on the other.

3.02 600-VOLT INSULATED CONDUCTORS

- A. Size. Install conductor sizes as indicated. Provide No. 10 AWG conductor for the entire circuit length for single-phase, 20-ampere circuits for which the distance from panelboard to the last outlet is more than 100 feet for 120-volt circuits or 200 feet for 277-volt circuits.
- B. Home Runs. Except where specifically indicated, provide branch circuit home runs with not more than two different line conductors and a common neutral in a single raceway for 3-wire, single-phase systems, nor more than three different line conductors and a common neutral in a single raceway for 4-wire, 3-phase systems. Use home run circuit numbers as indicated for panelboard connections.
- C. Color Code. Use factory-colored insulated conductors for No. 10 and smaller conductors and color code larger insulated conductors with an approved field-applied tape. Use different colors for control wiring. Follow the color scheme below.

Line	208/120	480/277
A or L1	Black	Brown
B or L2	Red	Orange
C or L3	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green
Switch Leg	Pink	Pink

Where more than one conductor of the same phase or more than one neutral conductor occur at the same outlet or junction box, these conductors shall be identifiable from each other by use of stripes or distinguishing markings.

- D. Field Testing. Insulation resistance of all conductors shall be tested. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps and connections are made except connection to or into its source and point (or points) of termination. Insulation resistance of conductors which are to operate at 600 volts or less shall be tested by using a Biddle Megger of not less than 1000 volts d-c. Insulation resistance of conductors rated at 600 volts shall be free of shorts and grounds and have a

minimum resistance phase-to-phase and phase-to-ground of at least 10 megohms. Conductors that do not exceed insulation resistance values listed above shall be removed at Contractor's expense and replaced and test repeated. The Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed, and shall forward copies of the test readings to the Owner in accordance with Section 16050. These test reports shall identify each conductor tested, date and time of test and weather conditions. Each test shall be signed by the party making the test.

END OF SECTION

SECTION 16130
RACEWAYS

PART 1 - GENERAL

1.01 SUMMARY

Provide electrical raceway systems:

A. Conduit.

1. Rigid aluminum conduit.
2. PVC-coated rigid aluminum conduit.
3. Rigid nonmetallic conduit.
4. Liquid-tight flexible metal conduit.

1.01 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.02 RELATED WORK AND SPECIFICATIONS

- A. Submittals. Section 01330.

1.03 REFERENCE STANDARDS

- A. ANSI C80.3 - Electrical Metallic Tubing - Zinc-Coated.
- B. ANSI C80.5 - Rigid Aluminum Conduit.
- C. ANSI/UL 360 - Liquid-tight Flexible Steel Conduit.
- D. ANSI/UL 467 - Electrical Grounding and Bonding Equipment.
- E. ANSI/UL 651 - Schedule 40 and 80 Rigid PVC Conduit.
- F. ANSI/UL 797 - Electrical Metallic Tubing.
- G. ANSI/UL 870 - Wireways, Auxiliary Gutters and Associated Fittings

1.04 SUBMITTALS

Submit product data in accordance with Section 01330.

PART 2 - PRODUCTS

2.01 CONDUIT AND FITTINGS

A. Rigid Aluminum Conduit.

1. Conduit. Rigid copper-free aluminum (alloy 6063-T1) conduit (RAC).
2. Fittings. Threaded aluminum.

B. Rigid Nonmetallic Conduit.

1. Conduit. Schedule 40 polyvinyl chloride (PVC).
2. Fittings. Solvent weld socket type.
3. Bodies. Form 8.

C. PVC-Coated Rigid Metal Conduit.

1. Conduit. Same as rigid metal conduit plus a factory-applied, 40-mil-thick covering of polyvinyl chloride (PVC) bonded to the metal. ETL verified PVC-001.
2. Fittings. Same as rigid metal conduit fittings plus a factory-applied, 40-mil-thick covering of PVC bonded to the metal.
3. Bodies. Form 8.
4. Training. Schedule and provide “hands-on” training for installing personnel on proper preparation, installation and touch-up.

D. Liquid-tight Flexible Steel Conduit.

1. Conduit. Spiral-wound, square-locked, hot-dipped galvanized steel strip plus a bonded outer jacket of PVC.
2. Fittings. Compression type, malleable iron, with insulated throat, either cadmium plated or hot-dipped galvanized.

2.02 WIREWAYS

A. Material. Not less than 16-gauge thickness.

B. Dimensions. Cross section dimensions not less than 4 inches by 4 inches.

C. Type.

1. Indoor non-corrosive areas. NEMA 12, painted steel.
2. Indoor corrosive and outdoor areas. NEMA 4 painted steel or NEMA 4x-FRP.

PART 3 - EXECUTION

3.01 CONDUIT AND FITTINGS

A. Minimum Trade Size.

1. Above Grade. ¾ inch.
2. Below Grade. 1 inch.

B. Types According to Use. Use rigid aluminum conduit (RAC) throughout the project except as specified below.

1. PVC RAC for above grade exterior conduit is not required on this project:
2. PVC-coated RAC or rigid nonmetallic conduit 1 inch and smaller may be embedded in slabs if the slab thickness is a minimum of 5 inches thick. Conduit placement shall not impair the slab's structural integrity.
3. Use PVC-coated RAC or rigid nonmetallic conduit encased in concrete, in accordance with Section 02581, with minimum 3-inch-thick walls, for conductors installed below grade at a minimum depth of 18 inches to top of conduit. All horizontal to vertical transitions shall be made using PVC-coated RAC elbows and PVC-coated RAC conduit stub-ups.
4. Use direct-buried PVC conduit for conductors installed below foundations. All horizontal to vertical transitions shall be made using PVC-coated RAC elbows and PVC-coated RAC conduit stub-ups.
5. Do not allow RAC to make direct contact with concrete or earth.
6. Do not use EMT.
7. Connect all electrical equipment subject to vibration or movement with liquid-tight flexible metal conduit 24 inches minimum length.
8. Transitions.
 - a. Where rigid nonmetallic conduit is used in concrete encasement or under concrete slabs, a conversion to PVC-coated RAC shall be made at least 3 feet before the run exits the encasement or slab cover.
 - b. For below-grade to above-grade locations, extend concrete encasement around conduit 4 inches above finished grade and slope top away from conduit with a 6-inch-per-foot slope. This

provision does not apply for conduits extending into pad-mounted or floor-mounted equipment.

C. Preparation. Place sleeves in walls and floor slabs for the free passage of cables or conduits. Set sleeves in place a sufficient time ahead of concrete placement so as not to delay the work. Seal all openings and voids around sleeves through floors and walls. Be sure that plugs or caps are installed before concrete placement begins.

D. Installation Requirements.

1. Metallic conduits must be continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, motor control centers, etc. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side. For RAC, provide nonmetallic insulating bushings for conductor protection. Where conduits 1-1/2 inches and larger terminate in equipment having a ground bus, such as in switchgear, motor control centers and panelboards, provide conduit with an insulated grounding bushing and a suitable grounding conductor terminated at the ground bus.
2. Have rigid nonmetallic conduit adequately solvent welded at joints to form a tight, waterproof connection.
3. Run concealed conduit as directly and with the largest radius bends as possible. Run exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Unless otherwise noted, remaining conduit may be exposed. Provide chrome-plated floor and ceiling plates around conduits exposed to view and passing through walls, floors, partitions, or ceilings in finished areas. Select properly sized plates to fit the conduit when securely locked in place.

E. Installation Methods.

1. Install each entire conduit system complete before pulling in any conductors. Clean the interior of every run of conduit before pulling in conductors to guard against obstructions and conduit omissions.
2. Cut all joints square, then thread and ream smooth.
3. Make bends with standard ells or conduit bent in accordance with the NEC. Make field bends using equipment designed for the particular conduit material and size involved. Bends must be free from dents or flattening. Use no more than the equivalent of four 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.

4. Conduit bodies may be used in lieu of conduit ells where ease of installation and appearance warrants their use. Conduit bodies larger than 1 inch may be used only where approved.
5. Securely fasten and support conduit to structure or metal framing using hot-dipped galvanized, malleable iron pipe straps or other approved means. Wires of any type may not be used for securing conduits. Branch circuit raceways which are 1 inch or smaller may be attached to wall studs by use of manufactured clips.
6. Provide a No. 30 nylon pulling line in conduits in which wiring is not installed under this work. Identify both ends of the line by means of labels or tags reading "Pulling Line - Telephone," etc.
7. Suitably cap conduit during construction to avoid water, dirt and trash entrance.
8. Use expansion-deflection fittings on conduit crossing structural expansion joints and on exposed conduit runs where necessary. Provide bonding jumpers across fittings in metal raceway systems.
9. With a coupling, terminate concealed conduit for future use at structural surfaces. Install a pipe plug flush with the surface.
10. Openings around electrical penetrations of fire-resistance rated walls, partitions, floors or ceilings shall be firestopped to maintain the fire resistance rating using approved methods.

END OF SECTION

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SECTION 16135
BOXES

PART 1 - GENERAL

1.01 SUMMARY

This section specifies the furnishing and installation of outlet boxes, floor boxes, junction boxes and pull boxes.

1.01 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.02 RELATED WORK AND SPECIFICATIONS

- A. Submittals. Section 01330.

1.03 REFERENCE STANDARDS

- A. ANSI/NEMA Publication No. OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers and Box Supports.
- B. ANSI/UL 514A - Metallic Outlet Boxes.
- C. ANSI/UL 514B - Fittings for Conduit and Outlet Boxes.

1.04 SUBMITTALS

Provide product data in accordance with Section 01330.

PART 2 - PRODUCTS

2.01 OUTLET BOXES

- A. Flush Device Boxes. Provide galvanized steel boxes of sufficient size to accommodate wiring devices to be installed at outlet. Provide an extension ring for the device(s) to be installed. Square or rectangular boxes may be used. Unless otherwise noted, provide minimum 1-1/2-inch deep by 4-inch square minimum size box.
- B. Exposed Device Boxes. Provide cast aluminum boxes for surface mounting in areas having exposed RAC.
- C. Switch Boxes. Not permitted.
- D. Listing. UL 514.

2.02 JUNCTION, PULL AND SPLICE BOXES

- A. Construction. Provide 316 stainless steel boxes conforming to NEC Article 370.
- B. Interior Spaces. Provide NEMA 1 type boxes at least 4 inches deep.
- C. Exterior Spaces. Provide NEMA 4X type boxes at least 4 inches deep.
- D. Embedded. Provide NEMA 4 cast iron type with flush flanged cover when cast in concrete.
- E. Listing. UL 514.

PART 3 - EXECUTION

3.01 OUTLET BOXES

- A. Flush Boxes. Unless otherwise indicated, mount all outlet boxes flush within 1/4 inch of the finished wall or ceiling line. Provide galvanized steel extension rings where required to extend the box forward in conformance to NEC requirements. Attach ring with at least two machine screws. Securely fasten outlet boxes. Provide plaster covers for all boxes in plastered walls and ceilings.
- B. Mounting Height. Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall. Verify the final location of each outlet with Owner's representative before rough-in. Remove and relocate any outlet box placed in an unsuitable location.
- C. Box Openings. Provide only the conduit openings necessary to accommodate the conduits at the individual location.

3.02 JUNCTION AND PULL BOXES

- A. Installation. Install boxes as required to facilitate cable installation in raceway systems. Generally provide boxes in conduit runs of more than 100 feet or as required in Section 16110.
- B. Covers. Provide boxes so that covers are readily accessible and easily removable after completion of the installation. Include suitable access doors for boxes above inaccessible ceilings. Select a practical size for each box and cover.

END OF SECTION

SECTION 16170
METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

Furnish and install metal framing, including channels, fittings, clamps, hardware, electrical accessories, and brackets.

1.01 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.02 RELATED WORK AND SPECIFICATIONS

- A. Submittals. Section 01330.

1.03 REFERENCE STANDARDS

NEMA ML 1 – Metal Framing.

1.04 SUBMITTALS

Submit product data in accordance with Section 01330.

PART 2 - PRODUCTS

2.01 CHANNELS, FITTINGS, CLAMPS, ELECTRICAL ACCESSORIES, AND BRACKETS

- A. Steel stainless, Grade 304 or above.
- B. Fabricate threaded fasteners of stainless steel.

2.02 SIZES

Provide channels fabricated from not less than 12 gauge thickness, 1-5/8 inches wide, and not less than 1-5/8 inches deep.

2.03 ACCEPTABLE MANUFACTURERS

B-Line Systems, Inc.; Elcen Metal Products Company; Electrical Products Division, Midland-Ross Corporation; Metal Products Division, U.S. Gypsum Company; Power Strut; Unistrut.

PART 3 - EXECUTION

3.01 SUPPORTS

Provide metal framing to support wall-mounted equipment, wall-mounted raceways, and ceiling-hung raceways.

3.02 ANCHOR BOLTS

- A. Use 1/2-inch diameter by 3 inches long stainless steel expansion bolts to attach framing to concrete.
- B. Space bolts a maximum of 24 inches on center, with not less than two bolts per piece of framing.

END OF SECTION

SECTION 16276
DRY-TYPE TRANSFORMERS - 600 VOLT PRIMARY AND BELOW

PART 1 - GENERAL

1.01 SUMMARY

Provide dry-type transformers with 600 volt and below primary and rated 500 kVA and smaller.

1.01 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.02 RELATED WORK AND SPECIFICATIONS

- A. Submittals. Section 01330.
- B. Operations and Maintenance Manuals. Section 01800.
- C. Metal Framing. Section 16070.

1.03 REFERENCE STANDARDS

Design, test, assemble and install in conformance to the latest edition of the following applicable industry standards.

- A. ANSI/UL 1561 - Dry-Type General Purpose and Power Transformers.
- B. IEEE C57.94 - Recommended Practice for Installation, Application, Operation and Maintenance of Dry-Type General-Purpose Distribution and Power Transformers.
- C. ANSI/NEMA ST 20 - Dry-Type Transformers for General Applications.
- D. NFPA 70 - National Electrical Code (NEC).

1.04 SUBMITTALS

- A. Submit the following information for each size and type of transformer being provided in accordance with Section 01330.
 - 1. Manufacturer.
 - 2. Rated kVA, number of phases and frequency.
 - 3. Primary voltage and connections.

4. Secondary voltage and connections.
 5. Number and percent taps.
 6. Outline dimensions.
 7. Total weight of unit.
- B. Submit the following information for record purposes at closeout in accordance with Section 01800.
1. O&M Manual. The manufacturer shall furnish with the submittal and with each unit delivered an equipment manual that details the installation, operation, recommended renewal parts list, and maintenance instructions for the specified unit.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Schneider Electric.
- B. General Electric.
- C. Eaton.

2.02 RATINGS

Required kVA, voltages, phases and winding configurations are indicated on the drawings. Transformers must be rated for 60 hertz operation, self-cooled NEMA Class AA and FA, and shall be listed under UL 506 or 1561.

2.03 COILS

- A. Windings. Use copper wire (bar stock) for coil windings.
- B. Taps. Furnish transformers with full load rated taps in the primary winding as follows:

KVA Rating	Taps
3-15 kVA, single phase; 9-15 kVA, three phase	Two 5 percent taps below rated voltage

2.04 INSULATION

Provide a 115°C insulation system which is the manufacturer's standard for a maximum 80°C rise over a 40°C ambient.

2.05 SOUND REQUIREMENTS

Average sound levels must not exceed the following values as measured in accordance with NEMA ST 20-4.12.

kVA	dB
10-50	45

2.06 CONSTRUCTION

- A. Enclosure. Install transformers with resin-encapsulated coils in totally-enclosed, ventilated metal enclosures designed to prevent accidental contact with live conductors. Enclosure to be stainless steel, Grade 304 or equal, and rated Nema 3R for exterior service.
- B. Wiring Compartment. Locate the wiring compartment below the core and coil. Have the compartment cooled by air circulation or insulated from the core and coil with a suitable thermal barrier.
- C. Grounding.
 - 1. Ground the core of the transformer to the enclosure with a flexible grounding conductor sized according to NEC requirements.
 - 2. Ground the transformer neutral in accordance with the NEC.

PART 3 - EXECUTION

3.01 TAP SETTING

Select the appropriate tap setting on transformer so that the actual secondary voltage is + 1/2 of a tap span at full load. Record the transformer serial number, kVA rating, selected tap setting and secondary voltage readings. Submit copies of the record to the Architect/Engineer.

3.02 CABLE CONNECTIONS

Make transformer cable connections with compression-type lugs suitable for termination of 75°C rated conductors. Position lugs so that field connections and wiring will not be exposed to temperature above 75°C.

3.03 MOUNTING

- A. Rack mounted. Construct unistrut (or equal) mounting rack for transformers and maintain a minimum of 6 inches free air space between enclosure and adjacent objects.

END OF SECTION

SECTION 16285
TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)

PART 1 - GENERAL

1.01 SUMMARY

Provide Transient Voltage Surge Suppresasion (TVSS) equipment having electrical characteristics, ratings and modifications as shown on the contract drawings and specified herein.

1.01 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.02 RELATED WORK AND SPECIFICATIONS

- A. Submittals. Section 01330.
- B. Operation and Maintenance Manuals. Section 01800.
- C. Panelboards - Distribution and Branch Circuit. Section 16442.

1.03 REFERENCE STANDARDS

- A. The TVSS units and all components shall be designed, manufactured, tested and installed in accordance with the latest applicable standards of the following:
 - 1. ANSI/IEEE C62.41 and C62.45.
 - 2. ANSI/IEEE C62.1 and C62.11.
 - 3. National Electrical Manufacturers Association (NEMA LS1 Guidelines).
 - 4. National Fire Protection Association (NFPA 70 [NEC], 75, and 78).
 - 5. Underwriters Laboratories (UL 1449, UL 1283 and UL 845).
 - 6. Underwriters Laboratories (UL 489 and UL 198).
- B. The unit shall be UL 1449 Listed and CUL Approved as a Transient Voltage Surge Suppressor and UL 1283 Listed as an Electromagnetic Interference Filter.
- C. The UL 1449 suppression voltage ratings (SVR) shall be permanently affixed to the TVSS unit.

1.04 QUALITY ASSURANCE

The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of 5 years. A list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.05 SUBMITTALS

- A. Submit the following information for review/approval in accordance with Section 01330:
1. Descriptive bulletins.
 2. Product sheets.
 3. Verification that the TVSS device complies with the required UL 1449 and UL 1283 suppression voltage ratings (SVR).
 4. Actual let-through voltage test data for both the ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (ringwave) tested in accordance with ANSI/IEEE C62.45.
 5. UL 1449 Listing/Clamp Voltages. Manufacturer shall provide data showing UL 1449 product listing. Manufacturer shall also submit certified documentation of applicable Location Category Testing in full compliance with NEMA LS 1, paragraphs 2.2.10 and 3.10.
 6. Single Pulse Surge Current Capacity Testing. Certified documentation of the unit's NEMA LS-1 Single Pulse Surge Current Capacity Testing shall be included in the submittal.
 7. Minimum Repetitive Surge Current Capacity Testing. Certified documentation of the unit's ANSI/IEEE C62.41 and ANSI/IEEE C62.45 Minimum Repetitive Surge Current Capacity Testing shall be included in the submittal.
 8. Electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
 9. Test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode and per phase basis using the IEEE C62.41, 8 x 20 microsecond current wave.
- B. Submit the following information for record purposes at closeout:
1. O&M Manual. The manufacturer shall furnish with the submittal and with each unit delivered an equipment manual that details the installation, operation, recommended renewal parts list, and maintenance instructions for the specified unit.

2. Drawings. Electrical and mechanical drawings shall be provided by the manufacturer with the submittal and with each unit delivered that show unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit. Include as-built information. Provide drawings with equipment manual.

1.06 EXTENDED WARRANTY

The manufacturer shall provide a full 5-year warranty, which shall initiate after the Owner has accepted the testing results and taken possession of the equipment, against any TVSS part failure when installed in compliance with manufacturer's written instructions and applicable national and local electric codes.

PART 2 - P R O D U C T S

2.01 MANUFACTURERS

- A. Allen Bradley.
- B. General Electric.
- C. Square D.
- D. Eaton.

2.02 TRANSIENT VOLTAGE SURGE SUPPRESSION - GENERAL

- A. Transient Voltage Surge Suppression (TVSS) equipment shall meet all ratings and features specified herein.
- B. Electrical Requirements.
 1. Unit Operating Voltage. Refer to drawings for operating voltage and unit configuration.
 2. Maximum Continuous Operating Voltage (MCOV). The MCOV shall be greater than 115% of the nominal system operating voltage.
 3. Operating Frequency. Range shall be 47 to 63 hertz.
 4. Protection Modes. For a wye configured system, the device shall have directly connected suppression elements between line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For a delta configured system, the device shall have suppression elements between line to line (L-L) and line to ground (L-G).

5. UL 1449 2nd Edition SVR. The maximum UL 1449 2nd Edition suppression voltage ratings (SVR) for the device shall not exceed the following:

Models	208Y/120
L-N, L-G, N-G	400V
L-L, L-G	800V

6. ANSI/IEEE Cat C3 Let-Through Voltage. The let-through voltage based on IEEE C62.41 and C62.45 recommended procedures for Category C3 surges (20 kV, 10 kA) shall be less than:

Models	208Y/120
L-N	533V

7. ANSI/IEEE Cat. B3 Let-Through Voltage. Let-through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Cat. B3/C1 ringwave (6 kV, 5000 amps) shall be less than:

Models	208Y/120
L-N	437V

8. Surge Current Capacity. Total surge current per phase (based on an 8x20 microsecond waveform) that the device is capable of surviving shall not be less than value listed below for each piece of equipment.

TVSS Exposure	Surge Current Capacity per Phase
High	300 KA
Medium	200 KA
Low	160 KA

9. Withstand. Each unit must be capable of surviving the following without failure degradation (>10%):
- Branch Circuit Panelboards. 5,000 ANSI/IEEE C62.41 Cat. C3 (20 kV, 10 kA).

10. Let-through voltage results shall be measured at the service entrance lugs.

C. TVSS Design.

1. High Performance Suppression System. Include an engineered solid-state high performance suppression system metal oxide varistors. The suppression system shall not incorporate components which may degrade performance or long-term reliability of the suppression system. Suppression system shall reduce transient levels and provide protection for sensitive electronics susceptible to catastrophic or long-term damage.
2. Electrical Noise Filter. Include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be greater than or equal to 44 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complementary listed to UL 1283.
3. Internal Connections. No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance copper conductors and compression fittings.
4. Remote Status Monitor. The TVSS device shall include form C dry contacts (one NO and one NC) for remote annunciation of unit status. The remote alarm shall change state upon detection of a fault condition.
5. Thermal Protection. Each suppression MOV shall be provided with thermal detection circuit to protect from overheating due to thermal runaway.
6. Diagnostics. Provide unit with following diagnostic features:
 - a. Audible alarm with silence, reset and test feature.
 - b. Indicator lights per phase.
 - c. System fault indicator (service indicator).
 - d. Surge counter.
7. Disconnecting Means. Provide circuit breaker or disconnect for servicing of TVSS unit.

2.03 FACTORY TESTING

Each unit shall be thoroughly factory tested before shipment. Testing of each unit shall include but shall not be limited to UL manufacturing and production-line tests, quality assurance checks, MCOV and clamping voltage verification tests. All tests shall be in accordance with the latest version of NEMA and UL standards.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All TVSS's shall be integrally installed inside the motor control centers and panelboards at the manufacturer's factory.
- B. Panelboard and motor control center installed units shall be circuit breaker protected.
- C. Provide TVSS's on motor control centers and distribution panelboards as indicated on one-line diagrams. Provide TVSS's on branch circuit panelboards as indicated on panel schedules.

END OF SECTION

SECTION 16442
PANELBOARDS - DISTRIBUTION AND BRANCH CIRCUIT

PART 1 - G E N E R A L

1.01 SUMMARY

Provide distribution and branch circuit panelboards.

1.01 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.02 RELATED WORK AND SPECIFICATIONS

- A. Transient Voltage Surge Suppressors. Section 16285.

1.03 REFERENCE STANDARDS

- A. ANSI/UL 50 - Cabinets and Boxes.
- B. ANSI/UL 67 - Electric Panelboards.
- C. ANSI/UL 508 - Industrial Control Equipment.
- D. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
- E. NEMA AB 3 - Molded Case Circuit Breakers and Their Application.
- F. NEMA PB 1 - General Instructions for Proper Handling, Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
- G. NFPA 70 - National Electrical Code (NEC).

1.04 SUBMITTALS

- A. Provide product data on panelboards and circuit breakers.
- B. Provide shop drawings with a schedule for each panelboard which indicates the circuit breaker arrangement and other pertinent features. Panelboard schedules must be identical to the schedules in the project documents unless there is a technical reason there must be a deviation. Submitted panelboard schedules must also contain confirmation of panelboard characteristics.

C. Shop drawings shall also provide the following information:

1. Breaker layout drawing with dimensions indicated and nameplate designation.
2. Component list.
3. Assembly ratings including:
 - a. Short-circuit rating.
 - b. Voltage.
 - c. Continuous current.
4. Cable terminal sizes.

1.05 QUALITY ASSURANCE

The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers.

PART 2 - P R O D U C T S

2.01 MANUFACTURER

- A. General Electric.
- B. Square D.
- C. Eaton.

2.02 ENCLOSURE

- A. Cabinet. Construct cabinets in accordance with UL 50. Construct boxes with corrosion resistant, zinc finish galvanized steel. Provide a minimum 4-inch gutter wiring space on each side. Reinforce cabinets and securely support bus bars and overcurrent devices to prevent vibration and breakage in handling. Provide cabinets without conduit knockouts. All conduit knockouts shall be made in the field. In unfinished areas such as mechanical and electrical rooms, galvanized sheet steel cabinets are sufficient, provided galvanizing occurs after components are cut or sheared.
- B. Doors and Trim.
 1. Interior Wet and Exterior Locations. Use manufacturer's standard door.
- C. Finish. Apply a finish to trim and doors consisting of two coats of enamel over a rust-inhibiting prime coat. Exterior finish shall be gray ANSI 61 paint. Interior finish shall be flat (non-gloss) white.

- D. Provide NEMA 3R/12 cabinets in interior wet and exterior locations.

2.03 BUS

- A. Fabricate phase, neutral and ground buses of 98 percent IACS conductivity tin-plated copper with rounded edges. Size bars as indicated and brace them to withstand symmetrical short circuit current as indicated on drawings. Install buses in allotted spaces so that devices can be added without additional machining, drilling or tapping. Use buses with silver-plated contact surfaces. Include copper neutral and ground buses rated not less than the phase bus ampacity.

2.04 PROTECTIVE DEVICES

Provide circuit breakers for the specified service with the number of poles, ampere and short circuit ratings indicated on panelboard schedules.

- A. Provide breakers which are quick-make and quick-break on both manual and automatic operation. Use a trip-free breaker which is trip indicating. Incorporate inverse time characteristic by bimetallic overload elements and instantaneous characteristic by magnetic trip. Where indicated, provide ground fault interrupters (GFCI).
- B. For 2-pole and 3-pole breakers, use the common-trip type so that an overload or fault on one pole will trip all poles simultaneously. Handle ties are not acceptable.
- C. Unless otherwise indicated on panelboard schedules, provide circuit breakers with the following minimum interrupting ratings:
 - 1. 10,000 rms symmetrical amperes at rated voltage for breakers rated 120 volts, single pole, or 208 volts, multipole.
 - 2. 65,000 rms symmetrical amperes at rated voltage for breakers rated 277 volts, single pole, or 480 volts, multipole.
- D. Connect breakers to the main bus by means of a solidly bolted connection. Use breakers which are interchangeable, capable of being operated in any position within the panel. Independently mount breakers so that a single unit can be removed from the front of the panel without disturbing or removing main bus, other units or other branch circuit connections.
- E. Cable lugs shall be copper/aluminum rated.

2.05 CIRCUIT IDENTIFICATION

For each panelboard, provide a steel directory frame mounted inside the door with a heat-resistant transparent face and a directory card for identifying the loads served. Type directory as specified in Section 16052.

2.06 LISTING

UL 67 - Electric Panelboards.

2.07 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)

Provide integral TVSS per Section 16285, Transient Voltage Surge Suppression (TVSS) - 600 Volt and Below.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install panelboards in the locations as shown and as recommended in NEMA PB1.
- B. Install the panelboards such that the center of the switch or circuit breaker in the highest position will not be more than 6-1/2 feet above the floor or working platform.

3.02 PROTECTION

- A. Temporary Doors. Panelboard cabinets shall be protected by a temporary door until the panelboard is energized. Temporary doors shall be 1/4-inch-thick plywood or equivalent rigid material. Temporary doors shall be installed when the cabinet is installed and shall remain closed at all times except when work is being performed inside the panelboard.
- B. Permanent Doors and Trim. Permanent doors and trim shall be installed immediately before panelboards are energized. Permanent doors and trim shall be maintained in factory condition after installation. Doors shall remain closed at all times except when the panelboard is deenergized and work is taking place within the panelboard.
- C. Cabinets. Cabinet interiors shall be maintained “white glove” clean at all times. Cabinet exteriors shall be maintained free of mud, spray-on insulation, paint spray and all substances not placed on the exterior surface by the panelboard manufacturer

END OF SECTION

SECTION 16450
GROUNDING

PART 1 - GENERAL

1.01 SUMMARY

This section specifies the furnishing and installation of grounding and bonding equipment for electrical systems.

1.01 MEASUREMENT AND PAYMENT

- A. Payment includes all materials, equipment, labor, and testing for complete installation as indicated on the drawings and described in this section and shall be included in the lump sum bid price for Electrical per project site.

1.02 RELATED WORK AND SPECIFICATIONS

- A. Submittals. Section 01330.

1.03 REFERENCE STANDARDS

Design, test, assemble and install in conformance to the latest edition of the following applicable industry standards.

- A. ANSI/IEEE Std 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- B. ANSI/UL 467 - Grounding and Bonding Equipment.

1.04 SUBMITTALS

Submit product data.

PART 2 - PRODUCTS

2.01 GROUND RODS

- A. Materials. Provide 3/4-inch by 10-foot long, copper-clad, steel grounding electrodes. Supply a rod to which the copper cladding is permanently and inseparably bonded to a high-strength steel core.
- B. Listing. UL 467.

2.02 CONNECTIONS

- A. Materials. Provide exothermic welded type connections for all grounding and bonding connections. Obtain written permission from the Engineer for the use of non-exothermic connections.
- B. Listing. UL 467.

2.03 WIRING

- A. Grounding Electrode Conductors. Bare tinned-copper conductors, minimum size of #4/0 AWG, stranded if not shown on dwgs. Provide THHN/THWN insulated conductor if routed inside rigid aluminum conduit.
- B. Equipment Grounding Conductors. Provide bare tinned-copper conductors for bonding jumpers. Provide 600-volt insulated stranded copper conductors having a green-colored insulation for equipment grounding conductors.
- C. Listing. UL 83.

PART 3 - EXECUTION

3.01 SYSTEM GROUND

- A. System Neutral. Where a system neutral is used, ground the system neutral as required by NEC Article 250. Ground the system neutral only at the point of service and isolate it from ground at all other points in the system.
- B. Separately Derived Systems. Solidly ground neutrals of separately derived systems such as generators, transformers, etc., in accordance with NEC 250-26, whether neutrals are actually installed or not.
- C. Size. Size the system grounding electrode conductors to comply with NEC Table 250-94, unless shown larger.
- D. Testing. Test the completed grounding system. If the resistance of the grounding system is greater than 5 ohms, add ground rods to attain 5 ohms.

3.02 EQUIPMENT GROUND

- A. Handholes. Provide a No. 4/0 AWG bare stranded copper ground bus in all handholes. Mount bus 12 inches above floor using one-hole pipe straps 3'-0" on center. Connect bus to ground rod with a No. 4/0 AWG conductor. Bond all metallic components, electrical grounding conductors and ductbank grounding conductors to the bus using lugs or clamps.
- B. Raceway Systems and Equipment Enclosures.

1. Ground cabinets, junction boxes, outlet boxes, motors, controllers, raceways, fittings, switchgear, transformer enclosures, other electrical equipment and metallic enclosures. Ground equipment and enclosures to the continuous-grounded, metallic raceway system in addition to any other specific grounding shown.
 2. Provide bonding jumpers and ground wire throughout to ensure electrical continuity of the grounding system.
 3. Provide grounding-type insulated bushings for metal conduits 1-1/2 inches and larger terminating in equipment enclosures containing a ground bus and connect the bushing to the ground bus.
 4. Provide a green insulated equipment grounding conductor for each feeder and branch circuit.
- C. Size. When grounding and bonding conductors are not sized on drawings, size the grounding conductors in accordance with NEC Article 250. Size bonding jumper so that minimum cross-sectional area is greater than or equal to that of the equivalent grounding conductor as determined from within NEC Article 250.

END OF SECTION

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